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## REPORT OF INVESTIGATIONS UPON THE ELECTRIC LIGHT AS USED IN PARIS.

By G. WARREN DRESSER, C.E.

In submitting the following results of investigations in Paris, during the past summer, into the practical workings of the electric light, it is with great satisfaction I am able to say that so far as the matter is as yet developed, there is nothing which should have a tendency to interfere in any way with the continued use of gas for all general purposes, public and private, as a means of furnishing the best, most satisfactory, and, probably, on any moderately large scale, the cheapest means of illumination. The electric light is thus far either a scientific light, or a light of luxury. It has its special uses, for which it may be well adapted; but GAS is still the light for the million.

I found in use, in various places in Paris and elsewhere, practically, two systems, viz.: the Jablochkoff, which requires no "regulator," and another system in which a regulator is used to keep the carbon points, at the proper distance apart, in order to have the "voltaic arc" formed between them. Of the latter there are several kinds, as made by different patentees.

It is principally in the arrangement of these regulators, and in the manufacture of the carbon points, that progress has been made; but there are none of them, nor any combination of any of them, that give a perfectly steady, uniform light. And I was informed by the officials in charge of the light houses at South Foreland, near Dover, England, where the electric light has been in use for seven years, that, so far as the carbon points were concerned, none gave such satisfactory results, after very many tests, as the plain sticks of carbon obtained by sawing them out from the cakes of carbon formed in gas retorts.

In both systems the electricity is derived from some form of magneto-electric machines, which are driven by power at a very high rate of speed.

The power used in Paris is principally steam, and the amount required is estimated by different electricians to be from one to five or six horse power per lamp; but I do not think that an average of two and one-half to three horse power per lamp would be far from the facts.

In some instances gas engines are used, and it was stated that a much more uniform speed was obtained from this motor than from any other. The Otto silent gas motor, which is now made to give eight horse power, works most satisfactorily, and is used with a consumption of gas not exceeding 35 cubic feet of gas per horse power per hour.

Unquestionably, the Jablochkoff system has attracted more attention than any other, and it gives me great pleasure to state that Mr. Jablochkoff himself, and his assistants, showed us every attention, and extended, in the most courteous and friendly manner, every facility and explanation in their power to enable us to judge of the matter.

There were present in Paris, at the time of my visit, in the latter part of June last, something over one hundred gas engineers, members of the British Association of Gas Managers, as well as about one hundred members of the French Association—the "Société Technique de l'Industrie du Gaz en France," all of whom were interested in the subject.

The conclusions arrived at are the results, not only of what I saw myself, but also of repeated consultations and conversations with many of these gentlemen.

I was also fortunate in meeting there, at the same time, two gas engineers from the United States whose reputation at home is too well established to require comment from me. They were Mr. Theobald Forstall, of New Orleans, and Mr. Malcolm S. Greenough of Boston; and, in many ways, I am indebted to them also for valuable aid in getting information.

The Jablochkoff candle, so-called, consists of two rods, or needles, of carbon placed side by side, and kept asunder, or insulated from each other, by a layer of plaster of Paris, or a mixture of plaster and kaolin. The carbons are made from retort carbon, ground fine and then pressed together, some cementing material having been added. They are each about one-eighth inch in diameter, and ten inches long, and are firmly fixed into metal sockets, to which the wires are led, and the connection with the machine is made. When new the tops of the two sticks only are joined by a small bit of carbon.

One of these will ordinarily burn from 1¼ to 1½ hours. The proportions adopted are those which experience has shown to be the best. Four of these are usually fixed on a stand and placed within a large opal glass globe, about 18 or 20 inches in diameter, on the top of a lamp post which is considerably higher than those commonly used here. As one of these "candles" burns down, the current is shifted to the next, and so on until the four are consumed. So that, at the outside, the street lamps would continue burning

six hours, when the set of four candles has to be replaced by others.

As a matter of fact, the various street lights of this system were lighted about seven or half past, and were all extinguished by 12 at night, when the gas lights were lighted and continued to burn till morning. Three steam engines and one gas engine furnish the power for the lights in the Avenue de l'Opera; and at the Orangerie, two 35 horse power engines are running six electric machines for the light there. It can be seen from this that quite a large item of expense would arise from the attendance required—first, to daily put the candles in place, and, secondly, to shift the currents from one to another candle as it burned down.

The price of each candle was stated to be 60 centimes, or 12 cents. If each one of these averaged to burn for 1¼ hours, the cost per hour of the candle *alone*, without charge for interest on machinery, etc., or cost of the necessary attendance, would be nine and three-fifth cents each. In the Avenue de l'Opera, the electric lights, when burning, take the place of about 10 gas lamps, and these gas lamps are much nearer together than in New York city.

At the present time the street lamps in New York, below Thirty-fourth street, are lighted for $12 per annum, including all charges for cleaning, painting, etc., or at the rate of *about* $1 per 1,000 cubic feet of gas furnished. The lamps are to burn three feet per hour; 10 of them would consume 30 feet per hour, and the cost for the gas, care, etc., of the ten lamps would be three cents per hour, or about one-third of the price of the Jablochkoff candle alone, as used in the Avenue de l'Opera in Paris.

What the other charges would amount to it is extremely difficult to determine, as we found the greatest dearth of actual data on this point.

I was informed that the estimated cost per hour of running four lights, carbons included, was three francs and 54 centimes, which would be 88½ centimes per hour per light, which would be equal to about 18 cents currency.

It is argued that while it costs more, there is much more light furnished; but this gives rise to the very important question as to how much of this additional light is *useful* light, leaving out of the account the character of it. And at this point I would most decidedly take issue with most of the estimates that the promotors of the electric light give of its value in standard candles. It is called a light of 1,000, 1,200, 1,500, even 2,000 candles.

I am willing to admit that when an attempt is made to patch up an ordinary photometer, and try to compare this intensely illuminated point with the light of ordinary candles, or even with the Carcel lamp, which is about 10 candles, the results indicate fabulous figures, and well they might, for a variation of 100 or 200 candles would thus be hardly perceptible. But what I mean to assert is this—that taking four of Mr. Sugg's triple ring Argands, which give a light of 250 candles each, and light them in any proper place, they would give much more light than the 1,000 candle power electric light.

The intensity of the electric light may show on the small shaded disc of the photometer a very high illuminating power. But the volume is lacking. It has not diffusive power. This results from surface of light, or the number of luminous points that throw off the light.

At the recent meeting of the British Association, in Dublin, J. R. Wigham explained the construction of the largest gas burner lights, as adopted by the Irish Light House Board, by which he obtains a column of light 13 feet high by three feet wide, and, in connection therewith, refers to this very point of intensity and volume in most apt language*, and actually suggests the idea of bringing into this column of light, as an auxilliary for intensity in extremely foggy weather, the electric light.

This is as it should be. The two lights may assist each other; and, doubtless, one result of the experiments in electric lighting, in streets and public squares, may be to cause the people to demand more light and better, and that can most easily and cheaply be obtained by increasing the size of the burners, improving the character of them, and increasing the number of the lamp posts. A perfectly reliable, well-diffused light, is the best police any city can have.

The electric light, as used in the streets of Paris, is not such a light.

Of the system of electric lighting where regulators are used we saw a number of specimens. The Serrin regulator was the first, I think, and has been in satisfactory use for years. But recently there has been much money, time, and talent devoted to the study of electric science, with a view of developing this light, and there have been many regulators presented for public approval. The most prominent are those of Messrs. Carrè, Jasper, Halte and Lontin.

The object of the regulator is to preserve the relative positions of the carbon points as they are being consumed. The light is formed as the current passes from one point to the other.

In order to start the light the points are in contact, so as to establish the circuit through them, then they are drawn slightly apart, say a distance of one-eighth of an inch, and the Voltaic arc is formed between the two ends. The object of the regulator is to hold the carbons in position, to maintain this short distance between the points, and to keep the carbon points moving toward each other as they burn away. It will be seen that such an instrument must be somewhat complicated and expensive; but yet there are several that appear to function almost perfectly when the carbons burn uniformly.

The lights from these lamps are not different in character from the other system. It is usually this kind of apparatus that has been applied in military and engineering works, to the lighting of foundries, railroad stations and other large areas. The testimony that we were able to obtain, as to the working expense, as well as the satifactoriness of the light given, was amusingly indefinite and contradictory.

At the station of the Lyons Railroad it had been in use for some time and discontinued. While one official told us that the light was unsatisfactory and expensive, and that that was the probable cause of returning to the use of gas light. Another claiming to know much of "the bottom facts" in the case, assured us that the cost was a mere trifle, and that the light was far superior to gas light.

The conclusion arrived at, on our part, was that the light had been replaced by gas for *some* reason, and that the gentlemen having the full account of the *cost* was not to be found.

At the station St. Lazar the electric light was in use in portions of the yard, and in freight houses, and preparations were being made to introduce it into the passenger station; but I understood that this was being done at the expense of the manufacturers of the apparatus for the purpose of trial.

It was claimed, by the promotors of the various systems, that there were as many as 1,000 applications of the electric light in France. It was at a season of the year when no artificial light was required in the various mills and other places where it had been introduced, and, consequently, no opportunity was afforded of seeing the practical working of the light in such places; but a correspondence with some of the parties who had tried it, resulted in about the same contradictory replies as in other places. One gentleman who was employing a large number of men, in the manufacture of artieles requiring great accuracy of workmanship, claimed it to be superior to any other light in all respects; while others who had tried it in mills, where weaving and spinning was done, pronounced most decidedly against it, and in some cases had discontinued its use.

The most perfect exhibition of the light that I saw was at the establishmeut of Messrs. Sautier & Lemonnier. This firm have been engaged for some time in making, among other mechanical work, lighthouse apparatus, and they are the makers of electric light apparatus for military and engineering purposes. They placed the regulator in a vessel which entirely concealed the direct light from view. This was suspended near the ceiling of a room about 30′ × 60′, well whitewashed on all sides, and at the top: all the light coming as a reflected light from the ceiling, and the piercing brilliancy of the lamp being cut off from view, the result was a very strong, well-diffused light, with but little shadow, but, nevertheless, very trying to the eyes when used for a short time.

M. Lemonnier also showed the use of the light in front of a reflector, fixed on a stand, with universal joint, so that it could be turned in any direction. These were on the balcony of a high tower; and I believe I am not exaggerating in the least when I state that a man could be clearly distinguished, at night, at a distance of three or four miles, when within the rays of light.

The color of different houses, three miles away, could be as easily distinguished as by daylight. And it is here, in special uses, that the electric light is of great value. I look upon its introduction as that of a coördinate branch of illumination, in the same way as the calcium light is; but I cannot see where any hostility or competition can arise between it and gas-lighting.

As to the

DIFFERENT MACHINES

used for generating the electricity there are the usual number of competitors. The more prominent is the one known as "the Alliance," perfected by Messrs. Nollet & Van Malderen. The Gramme, the Siemens, the Lontin machines, in France, and the Holmes and the Siemens in England; while we have in our own country several that are probably equal to any of them.

Then behind all these, viz., the carbons and the regulator, the cables connecting these, with the machines, and the machines themselves, comes the motive power. Steam boilers, furnaces, coal, stokers, etc., etc., so that it will be seen that it is not so simple a thing after all. And, what is more. Supposing the character, and cost, and quality of the light to be what is wanted exactly, it is not a reliable light, so simple are the causes that may extinguish it. In fact, there is no certainty that it may not go out at any moment.

Another point, which is a commercial one. How is the electric light to be measured and sold.

When gas is bought the amount of light that may be derived from it is known. The quantity is *accurately* measured, and the quality is officially determined. From all this statement you

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* See page 171 this JOURNAL.

will see I am sure that, as gas makers, the electric light may be welcomed by us as an ally and coadjutor, and not as an enemy.

Too much credit cannot be given to the zeal and energy with which the electricians of the present day have given themselves to this subject; and I cannot close this report without acknowledging the kindness and courtesy with which I was received and assisted by all of those directly interested in the electric light in Paris, to whom I applied for information and explanation.

To Mr. Jablochkoff, and his assistants, to Mr. Lemonnier, to Mr. Arson, chief engineer of the Paris gas-light company, Mr. Servier, President Societè Technique de l'Industrie du Gaz en France, and his associates, and to Mr. Fischer, of the Jury having charge of lighting and heating apparatus at the Exposition, I am under special obligations, and desire to return especial thanks for their aid, etc.

NEW YORK, OCT. 1ST., 1878.

## SIXTH ANNUAL MEETING OF THE AMERICAN GAS-LIGHT ASSOCIATION.

OFFICE OF AMERICAN GAS-LIGHT ASSOCIATION,
150 BROADWAY, N. Y. CITY.

The Sixth Annual Meeting of the American Gas Light Association will be held in the city of New York, on the 16th, 17th, and 18th days of October, 1878. The Meetings will commence at 10 o'clock, A.M., on the 16th. Headquarters and place of meeting will be at the Fifth Avenue Hotel, corner of 23d Street and Fifth Avenue. There will be a meeting of the Executive Committee of the Association, on the evening of the 15th of October, at 8 o'clock.

Members of the Association are reminded that this meeting is to be continued through three days, so that ample time will be had to discuss the topics and papers presented.

Members are earnestly requested to prepare papers, in their own way, on such topics as they would like to learn about, and bring them before the meeting for friendly discussion.

A meeting, large in numbers, is anticipated, full of interest, and of real value to every gas engineer and gas maker in America.

SEC. IV. of the Constitution gives the qualifications for membership, and reads as follows:

"To be eligible as an active member, a person must be a president, vice-president, director, secretary, treasurer, engineer, consulting engineer, or superintendent of a gas company, or an individual manager of a gas works, or a person practically skilled in the construction and management of gas works."

All persons eligible for membership, as above, are respectfully invited to become members of the Association, and, by so doing, benefit themselves and the gas fraternity generally.

CHARLES NETTLETON,
*Secretary.*

## Light-House Illuminations.

Before the Mechanical Science Section of the British Association, on Thursday, Aug. 15, Mr. J. R. Wigham read a paper on "New Applications of Gas for Lighthouses. Illustrated by models, full-sized apparatus, etc.:—1. The quadriform group flashing light, as used at Galley Head Light-house; 2. The combined gas and electric light for light-houses; 3. A mode of lighting sea beacons from a position on shore.

*The Quadriform Group Flashing Gas-Light, as used at Galley Head Light-House.*

Galley Head, a promontory on the Coast of Cork, about midway between Cape Clear and the Old Head of Kinsale, is a point in the neighborhood of which there have been several shipwrecks. The Commissioners of Irish Lights, therefore, determined to place there the most distinctive and powerful light which they could obtain. With this view, and acting upon the advice of Dr. Tyndall, their scientific adviser, they adopted the quadriform group-flashing gas-light, respecting which I now propose to say a few words.

It is perhaps known to some who are present that the Commissioners of Irish Lights were the first lighthouse authorities to make use of gas as an illuminant for important lighthouses. They have done me the honor of adopting the arrangements and burners for the consumption of gas which I have devised from time to time. My aim has been to combine the greatest possible intensity with the greatest possible volume in the gas flames which I employed.

Before showing you these flames, I may, perhaps, be permitted for a few minutes to explain some of the steps by which I was led to construct gas burners for lighthouses, in the form in which they are now used.

Up to the time of my first experiments, only Argand burners had been used for the combustion of oil in first-order lighthouses; but when it was attempted to construct Argand burners for gas, which should be of sufficient dimensions to give the same light as those used for oil, difficulties as to smoke and chimney-glasses interfered, and it became evident that some other method of burning gas must be sought for.

It occurred to me that if any plan could be devised by which the excess of carbon—the smoke—existing in rich gas flames could be turned to account as a means of increasing their illuminating power, a valuable desideratum would be obtained. I accordingly made many experiments with that object, and came to the conclusion that I could find no better basis for my efforts to that end than the ordinary well-known fish-tail jet. The fishtail jet, it is hardly necessary to say, is bored diagonally on opposite sides of a small internal cone. The streams of gas issuing from the orifices impinge against each other with considerable force, and the result is the thin sheet of flame with which we are so familiar. This flame, possessing a large surface, to which the oxygen of the air readily gains access, is in consequence rendered brilliant and comparatively smokeless. But on closely examining the flame of a fishtail burner, it will be seen that towards the top, where the force of the stream of gas is nearly expended, it is thicker, and inclined to be smoky. The larger the bore of the burner the thicker the stream of gas, and (its pressure and quality being good) the greater the amount of unconsumed carbon. When a number of fishtails are arranged so that the upper extremities of their flames touch each other, they run up, because of the absence of air between each jet, into smoky tails; but the light they give when thus united is increased, with hardly any increased consumption of gas, much beyond the mere multiple of their single flames, as may be seen in a moment by bringing two fishtails together. I made this peculiarity of the fishtail available for producing a large flame of high illuminating power, and I devised this form of burner. I used in its construction double jets, by which a more effective combustion of gas is attained with less consumption for each jet than in the burners which I used in my earlier experiments. The principle of the double jet is not new, but I believe that the present form of its application is entirely so. It is exceedingly simple, and may be explained by an ordinary gas burner.

It will be seen that the power of this burner is obtained by a peculiar arrangement of numerous fishtail jets, and it is increased by suspending over the flame which they unitedly produce an oxidizer, of talc, or other material, by means of which a current of air is brought in contact with its most smoky part, rendering it not only smokeless but exceedingly white. The combustion is also assisted by a bottom cone for equalizing the current of air to the flame. The oxygen of the air is thus twice availed of—first, at the bottom of the flame, through the medium of the several fishtail burners; and, secondly, at the top of it, where its action raises to a white heat the large quantity of solid carbon found there. This may be seen if I light a burner, which is one of the ordinary clear-weather lighthouse burners, and show it to you without and with its oxidizer. I may say, in passing, that burners like this are superior to any form of Argand burner in this important particular, that they require no chimney-glasses, the breaking and cleansing of which often cause much inconvenience in lighthouse maintenance, to say nothing of their presenting an obstruction to the passage of the light of the flame to the dioptric apparatus. I have on the table a complete Irish lighthouse burner. It is so constructed that a light-keeper can increase the power of the light by five steps, according as the state of the weather may seem to require it, from the burner used in clear weather, consisting of 28 jets such as I have just lighted, to the second, third, fourth, and fifth fog powers, consisting of 48, 68, 88, and 108 jets respectively. The changes from one power to another can be made very quickly by the use of mercurial joints, as I shall now show you.

With respect to these fog burners at which we have just been looking, I may say that while we all know that while there are fogs capable of obscuring any artificial light, and that even the sun's rays can but feebly penetrate dense fog, yet when fogs are not very dense, or when the weather is merely what is called "thick" (but sufficiently so to obscure ordinary lights), then it is that the mariner derives much benefit from powerful lights such as I have just shown you.

The power of the gas burner at which we have just been looking is, of course, very much increased by the use of lenticular apparatus. I have here what is termed an annular lens of the kind used for revolving or flashing lights in first-order lighthouses. I will move it in front of the 28-jet burner. You will see how a beam the full size of the lens is made to traverse every part of the horizon.

If, instead of using this ordinary lighthouse lens, which is designed for an oil-lamp flame four inches in diameter, 3½ inches high, I were to use a lens made to suit my large 108-jet gas-flame, which is 12 inches in diameter by 8½ inches high, I need not say that the illuminating effect would be enormously greater. I trust that before long lighthouse authorities will sanction the construction of such lenses, and so gain the full benefit of the large flames, which, so far as we know, gas only can produce.

Being fully convinced, from long practical observation, of the importance of using large lights to illuminate fog, I determined to push that principle to the utmost limit permitted by the lenses now used in the lighthouses, and I devised a plan by which, in foggy weather, double, treble, and quadruple the power of the largest gas light and

lens at which we have been looking can be obtained. This plan, which has been termed the biform, triform, and quadriform system, consists in placing two, three, and four burners respectively, vertically over one another, and making an arrangement by which the products of combustion of the lower burners are intercepted and turned outwards, so as not to interfere with the upper burners, while a supply of pure air is conveyed to each of them by cylindrical openings brought through the flues. The air thus introduced is sucked in briskly by the draught and much heated by its contact with the nearly red-hot casing of the internal flue. The illuminating power of each of the flames is thus materially increased.

That you may clearly understand the plan by which these lights are burned one above another, I have here arranged two such lights, and you will observe that so far from the upper being injuriously affected by the lower light, it is improved by the high temperature at which it is burned, and the constant supply of fresh air which is sucked in by the apparatus which I have described. Without this apparatus, you will see that the upper light has hardly any illuminating power.

I have here a model of the quadriform apparawhich I have erected at Galley Head. There are 32 lenses arranged in four tiers, eight in each tier. Each lens is of the size of this first-order lens, and one of these powerful gas lights is placed in the focus of each tier. Thus there are four burners placed over each other. As the lenses touch each other, the lights blend at a few yards distance, and form a great pillar of light about 13 feet high by 3 feet wide, the illuminating power of which is calculated to be equal to nearly a million sperm candles. This great illuminating power, it is to be remembered, is so under the control of the light keeper, that only one-fourth of it is applied in clear weather, the other three portions being reserved for application as the weather thickens. This light is the largest in the world, and it ought to be a source of satisfaction to the Commissioners of Irish Lights to know what they have done at Galley Head, in furtherance of the benevolent work to which they gratuitously give so much anxious attention, is likely to be of much benefit to the sailor. Indeed, since the completion of the Galley Head Lighthouse early this year, the Commissioners have received from the commanders of the great ocean steamers which pass Galley Head, the most satisfactory testimonials as to its power and distinctiveness. Can it be believed that there are persons who have expressed doubts whether the illuminating power of the quadriform is any greater than *one* of its four component lights? To convince such sceptics, and to afford the Members of the British Association an opportunity of judging the effect of this light, a first-order quadriform apparatus will, by the kind permission of the Commissioners of Irish Lights, be exhibited in comparison with the ordinary light at Howth Bailey lighthouse.

Before concluding, I should say that the light at Galley Head, besides being quadriform, is also what I have termed a "group-flashing" light—that is, the flashes from the lenses instead of being single flashes, as usually exhibited at lighthouses, are each of them, by the continual extinction and re-ignition of the gas, broken up into four or five beams, which constitute a group of flashes recurring at regular intervals, thus presenting a very distinctive light for the guidance of the mariner. This is accomplished by the same clockwork machine by which the lenses are caused to revolve. The interval between the groups of flashes is one minute, the interval between the flashes composing each group is about two seconds, during which the gas is cut off; a very considerable economy in the maintenance of the lighthouse is the result, only about one-half the gas which would be used in ordinary flashing light being consumed.

One word more as to these flashes. Just as the suddenness of the flash of a gun catches the eye, so the effect on the fog when large gas-burners, such as I have described, are *suddenly* lighted, is very striking; and the use of gas as an intermittent light for lighthouse purposes is valued, not only because of its economy (the intermission being due to the cutting-off and consequent saving of the gas), but also because of the illuminating effect on fog by the sudden exhibition of its great tight, as I have just mentioned.

*The Combined Gas and Electric Light for Lighthouses.*

The dimensions of the usual lanterns and dioptric apparatus of lighthouses not permitting us to use gas-lights of a larger size than that which I have just described, and of which I have shown you a full-sized drawing, it seemed desirable to consider whether we could not usefully add still greater intensity to our lighthouse gas flames than that obtainable from gas only. All our intense lights, such as the lime light, the electric light, magnesium light, etc., are costly; but it occurred to me that if I could add some such intense light to my large gas burners, so arranged that it need not be used except in thick weather, I would, at comparatively small expense, produce a fog light combining both quantity and great intensity. I made many experiments, and at length arranged for what I termed a core for my gas burners. Any of the intense lights I have mentioned might form this core. I first used, as the simplest and least expensive, a rich hydrocarbon flame intensified by oxygen, but I prefer the electric light because of its greater intensity, and because of the facility with which, owing to the recent improvements in the Gramme magneto-electric machine, it can be applied. When the Jablochkoff electric candle, which is now so much used in Paris, has been so constructed that it may be burned without variation for many hours together, it may be very easily utilised for the core of which we have been speaking; but, in the meantime, the light from carbon points regulated by a Serrin lamp, is quite available for that purpose. By a simple alteration in the arms which hold the carbons, and of the clockwork by which those arms are moved, we can bring the light into the precise focus of the gas burner, and apply it in a moment when occasion arises. By means of a gas engine, which, of course, can be used at all gas stations, it can be applied in a moment. With respect to this light, I will ask you to remember that it is only designed to be used during fogs, so that no expense is incurred except while the fog lasts, and during that time (it appears to me that) *no* expense should be considered too great when the possibility of saving human life is taken into account. By the kindness of the Commissioners of Irish Lights, one of these combined lights will be fixed at Howth Bailey Lighthouse, and an opportunity will be afforded to the Members of the British Association of judging of its effect in connection with the great quadriform light which, as I before mentioned, will also be placed in the experiment-house of that station. I have read the programme of this Association at Salthill by the light transmitted from this combined light at Howth Bailey Lighthouse, about six miles distant—a test of the power of a lighthouse light more severe than has ever before been applied, so far as I am aware.

I will only add that what I have said in the early part of this paper, respecting the useful effect of sudden flashes, in catching the eye of the sailor by what may be termed a momentary thrill in fogs and haze, peculiarly applies to this combined gas and electric light; this light when suddenly exhibited produces an exceedingly striking effect, well calculated to arrest the attention of the mariner.

*A Mode of Lighting Sea Beacons from a Position on Shore.*

When it is desired to establish and maintain lights upon beacons where space is limited, and to which access by boat is difficult or expensive, gas properly dried by chloride of calcium may be very conveniently applied as the means of illumination. A gas station on shore will command any desired number of beacons, and the lights may be simultaneously lighted and extinguished from the shore. The plan I have adopted, and exhibited in operation to the Commissioners of Irish Lights, is very simple. During the daytime the gas is supplied at a pressure, say, equal to a column of water six inches high, to maintain a small light about the size of a pea in the lantern of each beacon. The gas for this light is driven through a bye-pass in the valve of an automatic gas governor of suitable size fixed on each burner, and the high pressure at which the gas is supplied prevents wind or any slight movement of the supply-pipe from causing the extinction of the small flame, which thus remains as the permanent lamplighter of the beacon.

I will illustrate the tenacity of small flames burning at very high pressure by this simple experiment. I will supply a small flame with gas at six inches pressure of water, and then at one inch pressure. It will be seen that the least motion of the supply-pipe will extinguish it in the latter case, while it is comparatively difficult, if not impossible, by that means to extinguish it in the former case. At nightfall, when the time arrives for exhibiting the light in the beacon, the pressure at the shore station is diminished from six inches to, say, one inch, and this reduction of pressure immediately acts upon the governors which are attached to each light, causing their valves to open, and thus admit gas for a full-sized flame. When the beacon light requires to be extinguished, the reverse process is gone through, the pressure on shore is increased, the governor valve rises and extinguishes the light, leaving, however, the small by-pass pea-sized flame ready for the performance of its function as lamplighter on the next occasion.

The little apparatus which I have here will clearly illustrate this method of illuminating beacons. I will put it into action. You will see that to light and extinguish the light at the opposite side of the room I simply reverse the ordinary plan to which we are accustomed. I turn off this cock to cause the lights to spring up, and I turn it on to extinguish the light.—*London Journal of Gas-Lighting.*

## Inaugural Meeting of the Western Gas Managers' Association.

[Official Report.]

In answer to call of J. O. King, Esq., of Jacksonville gas company, calling together the gas managers and engineers of the West, for the purpose of forming a Western Association, the meeting was organized temporarily in the director's room of the St. Louis gas company, No. 511

Olive street, by the election of Mr. J. O. King, Chairman, and Lee A. Hall Secretary, whereupon the Chairman stated the object of the meeting.

On motion, it was ordered that Mr. E. J. King act as assistant secretary, who, in answer to request of several gentlemen present, gave a synopsis of answers to the call for the meeting.

On motion of Mr. T. G. Lansden, a committee of five (5) was appointed, consisting of Messrs. Lansden, Terry, Wallace, E. J. King, and J. C. Zabriski, to report articles of Association, for permanent organization, and the committee instructed to report at two o'clock, P. M.

On motion, the meeting adjourned until two o'clock, P. M.

Meeting called to order at two o'clock, P. M., pursuant to adjournment, Mr. J. O. King in the chair. Committee on permanent organization submitted the following Preamble and Articles of Associotion, which, after full discussion, were adopted.

PREAMBLE.

*Whereas*, The manufacture and supply of gas has become one of the largest economic interests of the county ; and

*Whereas*, It is important to the manufacturers and to the public that the best processes known shall be employed in its manufacture and distribution ; and

*Whereas*, It is most desirable to obtain the advantage of the experience of gas engineers scattered throughout the Northwest and Southwest, upon the various problems presented for consideration, we the undersigned, hereby agree to associate ourselves, for the above-named purpose, according to the following

ARTICLES OF AGREEMENT.

Article I—The Association shall be called the "Western Association of Gas Engineers and Superintendents."

Article II.—The annual meeting of the Association shall be held on the second (2d) Wednesday of May, in each year, at such place and hour as the directors shall determine.

Article III.—The officers of the Association shall be a President, two (2) Vice-presidents, a Secretary and Treasurer, who, with ten (10) other members of the Association elected for that purpose, shall constitue a "Board of Directors."

Article IV.—Any gas engineer, or superintendent, may become a member upon application to the board of directors, and an election by two-thirds of the votes at any regular meeting of the Association, and by signing the articles of agreement.

Article V.—Any person connected with the manufacture of illuminating gas, may become an honorary member, by the same vote as is required for the election of active members of the Association.

Article VI.—The administration of its affairs shall be entrusted to the officers of the institution, of whom five (5) shall form a quorum for the transaction of business.

Article VII.—The secretary and treasurer shall receive all moneys. He shall also notify all meetings. Take minutes of the proceedings at all meetings of the Association, and enter them upon propor books provided for the purpose. He shall write the correspondence, read minutes and notices at all meetings, and also papers and communications, if the authors wish it. Report discussions, and perform whatever other duties may be indicated in the regulations of the Association as appertaining to his department.

Article VIII.—At any regular meeting of the Association ten (10) members shall be a quorum for the transaction of business.

Article IX.—All questions shall be decided by any convenient system of open voting, the Chairman to have a second or casting vote when necessary. Questions of a personal nature shall be decided by ballot.

Article X.—All papers read at the meetings of the Association must relate to matters directly or indirectly connected with the manufacture of gas, and must be approved by the board of directors before being read.

Article XI.—All papers, drawings, or models submitted to these meetings shall remain the property of the author.

Article XII.—If any person proposed for membership, on being balloted for, shall be rejected, no notice shall be taken of the proposal in the minutes.

Article XIII.—The annual contributions shall be payable in advance, at or before each general meeting ; and no members whose contributions are in arrears shall be entitled to vote.

Article XIV.—An initiation fee of five (5) dollars shall be required on application for membership, and the annual dues be fixed at three (3) dollars per annum.

Article XV.—These Articles may be altered, or amended, at any annual meeting, notice of such change having been given at least one fortnight previous to such meeting.

The following gentlemen then enrolled themselves as members of the Association, in accordance with the above articles of Association, and paid the initiation fee as provided in Article XIV :

ACTIVE MEMBERS.

J. O. King, Jacksonville, Ill.
L. A. Hall, Louisiana, Mo.
W. Dunbar, New Albany, Ind.
Wm. Wallace, Lafayette, Ind.
G. B. Burns, Hannibal, Mo.
C. A. Lockwood, Ft. Worth Texas.
J. W. Butman, Decatur, Ill.
L. M. Moyes, St. Louis, Mo.
L. C. Jennings, St. Louis, Mo.
T. G. Lansden, St. Louis, Mo.
Chas. Erskine, St. Louis, Mo.
C. J. Lewis, Joplin and Carthage, Mo.
J. E. Powell, Paris, Ills.
Jacob Sitze, Paris, Ills.
E. J. King, Jacksonville, Ills.
A. M. Littleton, Quincy, Ills.
J. C. Zabriski, St. Louis, Mo.
S. Watts, St. Louis, Mo.
W. C. Faulkner, Shreveport, La.
J. K. Mitchell, Galesburg, Ills.
J. C. Lord, Washington, Ind.
M. Moran, Joliet, Ill.
L. Hoster, Little Rock, Ark.
J. M. Armstrong, Hannibal, Mo.

HONORARY MEMBERS.

Jas. Green, St. Louis, Mo.
Jno. Dell, " "
L. J. Howard " "
T. G. Russell, " "
Jno. Atkinson, " "

On motion, a committee of five (5) was appointed, consisting of Messrs. Butman, Zabriski, Wallace, Lockwood and Dunbar, to report permanent officers of the Association, and instructed to report at 10 o'clock to-morrow morning.

SECOND DAY, SEPT. 19TH, 1878.

Association called to order pursuant to adjournment, J. O. King, Esq., in the chair. Minutes of yesterday read and approved. Recess taken until 10 o'clock. Called to order at 10 o'clock, when the committee on permanent officers presented the following report, to wit :

*To the Western Association of Gas Engineers and Superintendents:*

Your committee, to whom was referred the question of permanent officers of the Association, beg leave to report as follows :

President—J. O. King, Jacksonville, Ill.

First Vice-President—J. C. Zabriski, St. Louis, Mo.

Second Vice-President—Wm. Wallace, Lafayette, Ind.

Secy. and Treas.—Lee A. Hall, Louisiana, Mo.

Directors—

Wm. Dunbar, New Albany, Ind.
T. G. Lansden, St. Louis, Mo.
J. W. Butman, Decatur, Ills.
C. A. Lockwood, Ft. Worth Texas.
Lewis Hoster, Little Rock, Ark.
A. W. Littleton, Quincy, Ills.
E. J. King, Jacksonville, Ills.
L. C. Jennings, St. Charles, Mo.
Geo. B. Burns, Hannibal, Mo.
C. J. Lewis, Joplin, Mo.

Who were all severally elected, and declared permanent officers of the Association.

On motion, a committee of three (3), consisting of Messrs. Hall, Lansden and Burns, was appointed to prepare a code of by-laws, and report same to the board of directors two (2) weeks before the annual meeting.

On motion of Mr. J. C. Zabriski, the thanks of this Association were tendered to Mr. Socrates Newman, Receiver St. Louis Gas Company, for use of director's room for the meetings of the Association.

On motion of Mr. E. J. King, the AMERICAN GAS-LIGHT JOURNAL was recognized as the official organ of the Association, in accordance with their letter, of August 28th, 1878, to J. O. King, Esq.

The following bills were presented, allowed, and ordered paid, viz.:

| | |
|---|---|
| T. D. Price & Co., pr't'g circulars, etc... | $13.50 |
| J. O. King, Postage and advertising..... | 9.75 |
| Janitor..... | 3.00 |
| Total..... | $26.25 |

On motion of C. A. Lockwood, the secretary and treasurer was instructed to procure the necessary books and stationary for use of his office.

Invitations to the Association to attend in a body were accepted as follows :

Mr. Lansden, to visit St. Louis gas works.

Mr. Zabriski, to visit Laclede gas works.

Messrs. Evens & Howard, to visit Cheltenham Works.

Invitations were tendered by several gentlemen, which could not be accepted for want of time.

On motion of Mr. Lansden, the thanks of the Association were tendered to Mr. J. O. King, for his efforts in effecting an organization of the Association.

On motion, the Association adjourned until the annual meeting (2d Wednesday in May) and the board of direction ordered said meeting to be held in Chicago, at 10 o'clock, A. M.

*Attest.*

LEE A. HALL, *Secretary.*

J. O. KING. *President*

[Concluded from page 150.]

## Recent Advances in Telegraphy.*

By W. H. Preece, Mem. Inst. C. E., Etc.

Other systems for increasing the capacity of wires have also been devised on the Continent. Thus Meyer (whose instrument was exhibited at the Vienna Exhibition of 1873, and is now in use on a small scale in France and Austria) sends four messages in the same direction apparently at the same time; but they are not sent simultaneously, the signals are divided and distributed so as to obtain the maximum carrying capacity of the wire, and, therefore, the practical gain is not great.

M. Baudot, whose apparatus is exhibited at the Paris Exhibition, sends five messages upon the Hughes apparatus in the same direction, but they also are not simultaneous, and though by utilising the intervals of time occupied by the type wheel in revolving and distributing the signals, he increases the capacity of the wire, the gain is not very different. The instrument is very complicated, and its practical success questionable.

The French government is also trying an automatic system of type-printing, devised by M. Olsen, which is said to increase the capacity of the Hughes type printer 33 per cent.

Now of all these systems, the most valuable, successful, and practical are the Wheatsone automatic and the quadruplex. The average speed attained on the automatic, on an average circuit worked simplex, is 100 words per minute, which becomes 200 words per minute when worked duplex. The average speed attained on the quadruplex is 120 words per minute. Hence, when duplexed, automatic is more capacious than the quadruplex, but the elasticity of the quadruplex makes it a valuable help to the automatic system, and when the two are combined (which has recently been done by the electricians of the Post-office) the advantages of both are secured.

But it must be remembered that each system has its disadvantages—principally the employment of a more highly trained staff. The automatic system involves previous preparation, and therefore preliminary delay. The complication and delicacy of both systems involve better-maintained lines, and their failure tends to much greater trouble. It is not advisable to trust all one's eggs to one basket. There is a distance within which each become disadvantageous and expensive, and where it is cheaper and better to erect extra wires.

Now these systems of fast-speed and multiplex telegraphy have grown up in England under the fostering care of the Post-office since the transfer of the telegraphs to the State; and, therefore, I contend that I am justified in saying that greater improvements have been made in telegraphy during the past eight years than in any previous period of similar duration.

Necessity drove the Americans to the introduction of quadruplex telegraphy, as it drove us to the employment of the automatic system. The increased business demanded increased capacity of wires. Automatic telegraphy in America was in the hands of opponents. All the skill of the Western Union Telegraph Company was devoted to the improvement of multiplex telegraphy, and the quadruplex is the result. Neither duplex nor quadruplex telegraphy were, however, invented in America. They were imported there, but in a very crude condition. The great practical skill and ingenuity of our cousins made them what they are—the most valuable adjuncts to telegraphy.

It will be observed that in the above enumeration England stands prominent as the home of the inventor. While she can boast of Wheatstone, Cooke, Bain, Thompson, Clark, Varley, Fuller, etc., and Europe can boast of Gintl, Siemens, Frischen, Meyer, etc., America has her Morse, Hughes, Stearns, Edison, and Gray.

In 1868 the Western Union Telegraph Company, feeling that their telegraphic system was not up to the requirements of the age, secured the valuable services of Mr. Cromwell Varley, who educated them up to the European standard of electrical knowledge, and they have certainly bettered their instruction.

America has freely adopted our system of pneumatic telegraphy. They have adopted Johnson's method of manufacturing iron wire. They have introduced on some lines automatic telegraphy, modified by Messrs. Little and Edison. They are trying our superior batteries.

Hence while we have not been slow to avail ourselves of their advances, they have equally availed themselves of our progress.

Telegraphy is thus cosmopolitan. Whatever of value and advance is produced in one nation is adopted by all. Invention has not left the shores of England. The English Telegraph Department stands in the first rank. Foreign Governments freely avail themselves of our experience. Our models, our plans, and our manufactures are found in every clime.

It remains for me to say a few words as to the part played by the Post-office in fostering these advances. The system of new wires is unique in its kind. Forty-seven new circuits and twenty-two special wires are made up every day for the transmission of intelligence. News is transmitted direct from London to every town at which a daily paper is published. There is thus scarcely a town in the country where every man has not on his breakfast table a morning paper containing the debates of Parliament of the previous night.

This is maintained by the automatic system. Half a million words are frequently sent in one night from London alone. When Lord Beaconsfield gave his address in the House of Lords on the results of the Berlin Congress, 526,250 words were transmitted from "T.S," the central station.

There is not a branch of the service that has not been improved. New batteries, new insulators, preserved poles, improved wires, the most perfect relays, and multiplex apparatus have all found their way into the Post-office service. In 1873, 15,535,780 messages were transmitted over 105,285 miles of wire, being an average of 147 messages per mile of wire, while in 1878, 22,171,782 were sent over 113,333 miles of wire, being an average of 200 messages per mile of wire. Of the 8,000 miles of additional wire which have been put up, more than one-half is for private purposes; therefore the message average is really even higher than that given. Indeed, only 4,000 miles wire have been erected to transmit nearly seven millions messages, or an increase of nearly 50 per cent. of work.

No one has ever been found to complain of the action of the Post-office in adopting improvements but, perhaps, some disappointed inventor. It must be remembered that improvement is invariably the result of inventive power combined with practical experience well tempered with theoretical knowledge. Practical inventions rarely emanate from without. The long list that I have enumerated is, without exception, composed of men who have possessed these qualifications; but the great majority of patents are taken out by those who do not possess them at all. They are the most troublesome men to deal with. They cannot be convinced of their errors, and their want of experience prevents them from seeing their failure; but of the numerous patents that are annually taken out, how many complaints are made by those who have not been fairly and properly treated?

They are now as numerous as ever, indeed, the average of the last eight years exceeds that of the previous eight; hence I am justified in saying that the possession of the telegraphs by the State has not checked improvement. Moreover, the telegraph system outside that of the Government is as great now as the whole telegraph system of the country was before the transfer; and inventors, if they are dissatisfied with the Government, have the numerous cable companies and the great railway systems of this country to fall back upon. Private enterprise is not dead.

The fact remains that telegraphy, whether for commercial or railway purposes, is more highly developed in England than in any other country, not excepting America, and this development is due as much to the action of the State in purchasing and managing the commercial system of the country as to the competition that remains between nation and nation and between company and company. The lines of the Post-office are now worked with a view to a fair commercial profit as much as any private concern. The action of the Government in all departments is jealously watched by its master, the public. This master is not always just nor generous. Its prerogative is to find fault with the Government in all that it does, and it is well that this right be exercised, for it forms a very valuable check on abuse, it strengthens discipline, and it secures a worthy discharge of duty.

I can speak from the experience of a commercial and of a Governmental department extending over twenty-five years, and I have no hesitation whatever in asserting that there is as much zeal, energy, and enterprise in the one as there is in the other. The control of Parliament and of the press exercises a far more disciplinary and supervising power on the management of a Government Department than any half-yearly meeting of shareholders or occasional committee of investigation.—*Journal of the Society of Arts.*

* Paper read before Section G of British Association, Dublin, 1878.

## A Strange Death.

A strange death from the effects of gas occurred on Mulberry street yesterday. The victim, a young man named Henry Farber, in the employ of Messrs. Connell & Battin, of Penn avenue, had been detailed to do some work in the cellar of Wm. P. Connell's residence, about 4 o'clock in the afternoon, and had not been there very long before he was found dead over an open gas pipe, which he was in the act of repairing. The circumstances showed that he took off the cap of the gas pipe and inserted a wire to remove some supposed obstruction. This doubtless occasioned a rush of gas, causing instant asphyxia and ultimate death. The escape of gas attracting the attention of Mrs. Connell in the parlor, she sent a servant down stairs with instructions to have it turned off as speedily as possible. The girl delivered her message to the dead man, and returned with the remark that he looked and laughed at her. Seeing that the gas was increasing rather than abating, Mrs. Connell went into the cellar to see that it was turned off, and there found young Farber prone and helpless. Assistance was called in, and he was promptly removed to the porch, where it was discovered, much to the astonishment of all, that life was extinct. Dr. Squires was speedily at hand, but Farber had already passed beyond the reach of medical skill. Deceased, who was about 19 years of age, was an apprentice of Messrs. Connell & Battin.—*Scranton Republican, Wednesday, Oct. 2.*

THE AMERICAN GASLIGHT JOURNAL AND CHEMICAL REPERTORY

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WEDNESDAY, OCTOBER 16, 1878.

## Official Report of Examinations of Gas for two Weeks ending Oct. 12, 1878, made at the Photometrical Room of the Department of Public Works.

Corrected Illuminating Power.

| Sept. 1788. | Time of Day at which Test were made. | New York Gas Light Co. | Manhattan Gas-Light Co. | Mutual Gas Light Co. | Metropolitan Gas-Light Co. | Harlem Gas-Light Co. | Municipal Gas-Light Co. |
|---|---|---|---|---|---|---|---|
| 30 | | 17.14 | 17.82 | 21.68 | 17.11 | 16.48 | |
| Oct. 1 | Between | 16.87 | 18.42 | 21.48 | 17.08 | 16.24 | |
| 2 | 9.30 A.M. | 16.62 | 18.25 | 21.03 | 17.20 | 16.66 | |
| 3 | and | 16.60 | 18.12 | 20.72 | 17.25 | 16.72 | |
| 4 | 1 P. M. | 16.48 | 17.86 | 20.52 | 17.32 | 16.77 | |
| 5 | | 16.60 | 18.10 | 20.01 | 17.18 | 16.58 | |
| | Average | 16.72 | 18.09 | 20.90 | 17.19 | 16.57 | |
| 7 | | 17.11 | 18.18 | 20.65 | 16.94 | 16.30 | |
| 8 | | 17.31 | 18.06 | 20.53 | 16.73 | 16.00 | |
| 9 | | 17.64 | 17.84 | 20.37 | 17.20 | 15.70 | |
| 10 | | 16.79 | 17.33 | 20.02 | 16.68 | 15.21 | |
| 11 | | 16.89 | 17.98 | 21.08 | 17.01 | 15.77 | |
| 12 | | 16.50 | 16.84 | 21.18 | 17.40 | 15.75 | |
| | Average | 17.04 | 17.70 | 20.64 | 16.99 | 15.79 | |

Sugg-Letheby burner.
E. G. LOVE, Gas Examiner.

**Self Illuminating Clocks.**—It is said that a curious clock is to be introduced by the Ansonia Clock Company of New York. The dial, which to all appearances is of ordinary porcelain, becomes luminous when placed in the dark, so that the hands and figures can be plainly seen, and the time easily distinguished. It is the invention of a French chemist, and is thought to be imperishable.—*Polytechnic Review.*

[From "Journal of Gas Lighting."

## British Association of Gas Managers.

Mr. F. D. MARSHALL (Brentford) read the following paper on

PURIFICATION BY MEANS OF LIQUIDS, PRINCIPALLY CAUSTIC AMMONIA.

Many attempts have been made to effect the removal of $H_2S$, $CO_2$, and the so-called sulphur compounds, by means of liquid reagents in closed vessels, and to dispense with the use of the objectionable lime or oxide of iron. As day by day the pressure is brought to bear, truly the unhappy gas companies are between the horns of a dilemma, for, in obedience to popular prejudice, while those wiseacres, the local authorities, insist on the removal of a few grains of sulphur, they in the same breath as much as forbid us the only practical means of accomplishing this end. Of champions in the cause, their name is legion—Wilson, in 1813; Phillips, 1843; Farmer, 1847; Mann, 1853; Laming, 1853, 1854, 1855; Leigh, 1866; Hills, 1870, 1874, 1875, 1877; Patterson, 1873; Paterson and Collinge, 1877; Evans and Sugg, Wallace and Claus, 1878, have all sought protection of the Patent Office for processes to effect the purification by liquids in some form or other, and we seem, in a measure, to be approaching the desired end.

Of the originality of some of the schemes it would be invidious to speak, for many seemed bent on treading in the footsteps of their predecessors, and original ideas cropped up at intervals, few and far between, although it is but fair to mention that a somewhat original path was carved out by Mr. G. Livesey, who purposed desulphurating the liquor by means of furnace gases, a detailed description of which appeared before you in 1875.

In the majority of the patented schemes ammoniacal liquor plays the principal part, and this can scarcely be wondered at when we think of the peculiar advantages "liquor" presents for the purpose, possessing as it does a large supply of ammonia, which, in its free state, is capable of absorbing both CO and $H_2S$ quite as readily as lime itself; but, as the $NH_3$ is now obtained, it is bound up, so to speak, with $CO_2$ and $H_2S$, and to free it from these, in an economical manner, is the question we are all so earnestly endeavoring to solve. Many patents purposed treating ammoniacal liquor with caustic lime, and so converting the $CO_2$ into carbonate of lime, and setting free an equivalent quantity of ammonia, and another form purposed the decomposition of the liquor by heat, driving the gases thus set free through oxide of iron and lime. But these plans would present difficulties, for a large amount of aqueous vapor would pass over with the evolved gases, and be condensed in the lime, rendering it cloggy and non-porous; and to prevent this the lime would have to be kept hot and dry, to give free passage to the gaseous sulphide or caustic ammonia.

To test the feasibility of these plans, I was instructed by Mr. Woodall, while at the Phœnix Gas Company, to make some experiments, by adding caustic lime to gas liquor, and these showed the impracticability of accomplishing anything in this direction, for, besides losing a large quantity of ammonia, it was difficult to regulate the quantity of lime added to the liquor, in order only to precipitate the carbonic acid, for should the lime exceed a definite quantity, the sulphuretted hydrogen would be absorbed with the carbonate as sulphide, and ultimately as bisulphide of calcium, and as such would be most voluminous and difficult of disposal. Should any one feel disposed to push inquiries in this direction, the following data, showing the quantity of lime required for a gallon of liquor of 8-ounce strength to precipitate the $CO_2$ alone may be useful: One bushel of lime requires 12 pounds of water to slake it, and 0·253 pounds of slaked lime are required to every gallon of 8-ounce strength to precipitate the $CO_2$.

This process was, however, partly anticipated by Livesey's patent in 1865.

Much publicity has been given to Hill's process, the details of which we are now familiar with. Suffice it to say, he aims at the production of caustic ammonia by heating the liquor to a temperature of 180°, whereby the $CO_2$ and the $H_2S$ are separated from the $NH_3$, the two former passing away, while the latter is re-absorbed by fresh liquor and carried back to the boiler. Of the effectiveness of this scheme I speak guardedly, for while, on the one hand, I am assured by Mr. George Livesey that he has worked it successfully, and intends purifying nearly the whole of his gas from $CO_2$ and $H_2S$ by this means, yet I am in a position to quote analyses of liquors obtained from the outlet of boilers where this process was under trial, and these revealed the fact that the action was not complete, and that the $NH_3$, in all the samples taken, existed nearly wholly in the combined state—that is, as carbonate and sulphide of ammonium—and the free ammonia in no case exceeded more than 0·144 per cent. As the actions spoken of only take place within the limits of certain temperatures, considerable difficulty was experienced in maintaining the boilers at an equable temperature.

Another process for the removal of the $H_2S$ was that of Marriott, of Huddersfield, and extensive trials were made of the process at the Vauxhall station of the Phœnix Company about a year ago. It principally consists in breaking up the $H_2S$ in crude gas by means of sulphurous acid ($SO_2+2H_2S=2H_2O+3S$), whereby the oxygen in the $SO_2$ combines with the H of the $H_2S$, forming water, and the equivalents of sulphur from the $SO_2$ and the $H_2S$ are eventually recovered, to be used over again in the manufacture of sulphurous acid gas. To effect this the sulphurous acid is brought into contact with the gas liquor, converting it first into a sulphite, and then into a bisulphite of ammonia, and in this condition it is used for scrubbing the gas. So far as the removal of the $H_2S$ was concerned, the plan was perfectly successful; but the chief drawback was due to the destructive influence of a certain amount of free $SO_2$ on the iron employed in the construction of the pumps and apparatus; but there is no doubt this may be remedied by the employment of lead, stone, or gutta percha in the construction of the apparatus. Neither the $CO_2$ nor sulphur compounds were acted upon by the bisulphite of ammonia; but, on Mr. Marriott's authority, by treating the bisulphite of ammonia with an excese of $SO_2$, it can be converted into a pentathianide of ammonia, and in this condition the inventor states he has removed bisulphide of carbon compounds.

But practically we were never able to impregnate the liquor with more sulphur than to form a bisulphite. The whole process can scarcely be called original, for in 1831 Lowe and Croll, 1856 Gossage, 1862 Livesey, and 1869 Bauher and Dale, took out patents all more or less covering the same ground, the only difference being that some employed free $SO_2$, while others used ammonia as the carrier of the $SO_2$.

It seems admitted, beyond doubt, that both $CO_2$ and $H_2S$ may be efficiently removed by caustic ammonia, or purified gas liquor, but how far the sulphur compounds are affected by sulphide of ammonium or purfied gas liquor we have not extensively published data. That they are affected by sulphide of ammonium, and by soluble and insoluble sulphides, we are prepared to admit. I have had occasion to made experiments in this direction, and began with crude gas liquor of 9-oz. strength, with 1-20th part of alcohol added. This was passed through scrubbers filled with pumice stone, with this effect—Sulphur at inlet of scrubbers, 23 grains, and at outlet, 12 grains, the difference being 11 grains. Several series of experiments bore out these results.

The experiment was repeated without alcohol; the sulphur, however, at the inlet was 33 grains, and at the outlet, 22 grains; difference, 11 grains. An abnormally strong liquor was then obtained, viz., 29-oz. strength, and used in a similar manner, but without any alcohol. The results were—Inlet of scrubbers,

30 grains, outlet, 16·5 grains; difference, 13·5 grains. Unfortunately, a correct measurement of the liquor was impracticable, so large was the amount carried away by the passage of the gas, but as long as it lasted it seemed cabable of doing good work.

These experiments were made on gas free from $H_2S$, but containing 0·8 per cent of $CO_2$. During the experiments frequent trials were made to ascertain any diminution of condensable hydrocarbons or carbonic acid, and we found—

| | | |
|---|---|---|
| Inlet of scrubbers: | | |
| Condensable hydrocarbons..... | 4·0 | per cent. |
| $CO_2$..... | ·8 | " |
| Outlet of scrubbers: | | |
| Condensable hydrocarbons..... | 4·0 | " |
| $CO_2$..... | ·6 | " |

showing no diminution of hydrocarbons, but a reduction of 0·2 per cent. of $CO_2$. These experiments were repeated with sulphide of ammonium, and the average result of a series of trials showed a reduction of 27 grains to 17 grains of sulphur—difference, 10 grains. With caustic ammonia the results were very variable; but a reduction of 10 grains of sulphur could easily be obtained. To my mind it seems that, with more efficient scrubbing power, and longer contact of the gas with the reagent, much greater diminutions might be effected, and this has been borne out by a further series of experiments, also under the direction of Mr. Woodall, with another soluble sulphide—viz., sulphide of barium—patented by Messrs. Wallace and Claus. This baric sulphide is prepared from sulphate of baryta, found in large quantities in Derbyshire and all lead-bearing districts, and known locally by the name of "cowk."

After being crushed with an equivalent of powdered coal, and heated in a reducing furnace, the sulphide of barium thus formed is dissolved out, and is ready for use. For the experiments, which extended over some months, two towers, 24 inches in diameter, and 9 feet high, were used, fitted with a "tumbling-box" distributor, and the average of the observations showed that 40 gallons of saturated barium sulphide purified 9,000 cubic feet of gas, reducing the sulphur from 26 grains at inlet to 6·3 grains at outlet, making a difference of 19·7 grains.

The average quantity of gas per hour was 1,200 cubic feet. Had the towers been of larger capacity, and the scrubbing area increased, the work done by the barium would have been probably much greater.

Experiments made by Mr. Frank Morris, engineer at Brentford, showed like good results. There is, however, one great difficulty to contend with, when dealing with barium, and that is its great tendency to become both carbonated and oxidized by the action of the atmosphere, and great precautions must be taken to keep it covered up and free from exposure Mr. Marriott is now, I believe, experimenting at the Fulham Gas Works with another sulphide—viz., sulphide of sodium—and we shall, no doubt, shortly hear with what results.

And now we come to review these systems of purification for the production of caustic $NH_3$, we find ourselves at the unprofitable and scarcely amusing occupation of carrying the parson around the church, for we are reduced to the clumsy and wastful process of treating liquor with lime, or vice versa, by which we create a bulky waste product of carbonate of lime, and the $CO_2$ and $H_2S$, which ought to play their parts in the purification, are entirely lost or rendered useless, and the whole thing is nothing but lime purification by proxy. And presuming we have economically manufactured the caustic $NH_3$, we are by no means certain of the best means of introducing it to the gas, so as to avoid an excessive and unprofitable washing power for removing the $NH_3$, that the gas must necessarily assimilate during its passage; and in the case of purification by sulphides, we must, for cogent reasons, remove first the $CO_2$, and perforce use the familiar oxide to remove the $H_2S$ carried forward by the gas, while in the case of sulphide of ammonium, both washing and oxide must be had recourse to.

I mentioned that we must first rid the gas of $CO_2$ before entering a sulphide purifier or vessel; for those of us who are unfortunately compelled to use lime purification are fully alive to the influence of $CO_2$ on sulphide purifiers—viz., the expulsion of the $H_2S$—and this equally applies to liquid reagents, as the following experiments made at Vauxhall satisfactorily show:—

Four small scrubbers were employed, and sulphide of ammonium was put into the first two scrubbers, and caustic ammonia into the second two. Assuming the crude gas to contain 4 per cent. of $CO_2$, the theoretical quantity of gas required to be passed to convert the sulphide of ammonium into the monocarbonate would be 39 cubic feet, or into the bicarbonate, 78 cubic feet. The composition of the sulphide of ammonium in scrubbers Nos. 1 and 2 was—

| | | |
|---|---|---|
| Ammonia..... | 4·90 | per cent. |
| Sulphuretted hydrogen..... | 3·25 | " |

After passing 20 cubic feet of crude gas at the rate of 6 feet per hour—

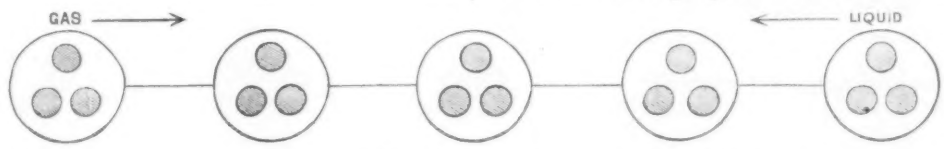
| | | | | |
|---|---|---|---|---|
| No. 1 scrubber contained..... | 1·48 | per cent. of | $H_2S$ |
| 4 " " ..... | 1·56 | " | " |

After, however, 83 feet had passed—

| | | | | |
|---|---|---|---|---|
| No 1 scrubber contained..... | ·60 | per cent. of | $H_2S$ |
| 2 " " ..... | ·72 | " | " |
| 3 " " ..... | ·58 | " | " |
| 4 " " ..... | ·58 | " | " |

After passage of 140 cubic feet—

| | | | |
|---|---|---|---|
| No. 1 scrubber contained..... | ·66 | per cent. of | $H_2S$ |
| 2 " " ..... | ·65 | " | " |
| 3 " " ..... | ·68 | " | " |
| 4 " " ..... | ·58 | " | " |
| No 1 scrubber also contained. | 6.89 | " | $NH_3$ |
| " " " ... | 9·66 | " | $CO_2$ |
| " " " ... | ·66 | " | $H_2S$ |
| No. 3 " " ... | 5·50 | " | $CO_2$ |
| " " " ... | ·68 | " | $H_2S$ |




Thus it will be seen that in the first scrubber (originally containing sulphide of ammonium) we get an increase of ammonia from 4·9 per cent. to 6·89 per cent. We also find 9·66 per cent. of $CO_2$. To convert the 6 89 per cent. of $NH_3$ into monocarbonate of ammonia, it would require 8·9 per cent. of $CO_2$, or a proportion of 22 of $CO_2$ to 17 of $NH_3$; instead of which we have 9·66 per cent. of $CO_2$, or a proportion of 24 of $CO_2$ to 17 of $NH_3$, clearly proving the formation of a bicarbonate of ammonia, and a thorough expulsion of the $H_2S$; for as $H_2S$ cannot exist along with sesqui or bicarbonate of ammonia except in the free state, the 0 66 per cent. of $H_2S$ remaining must have assumed the free state, and have been held mechanically in solution—that is, about 15 per cent. of the original 3·25 per cent. of $H_2S$ remained in the free state after all the ammonia had been converted into more than monocarbonate of ammonia. The experiments were carefully conducted, and the $CO_2$ and $H_2S$ in the liquors determined by volumetric analysis.

This clearly points to the fact that $CO_2$ is absorbed by sulphide of ammonium with expulsion of $H_2S$, and that a mono or bicarbonate of ammonia is formed; but how far the absorbtion of $CO_2$ takes place in ordinary scrubbers may be gathered from the carefully conducted and beautifully recorded experiments made by Mr. M'Minn at the Fulham station of the Gas-Light and Coke Company. The average of a number of trials extending over a long period of time, showed at the inlet of scrubbers 2·002 per cent. by volume of $CO_2$, and at outlet, 1·764 per cent.—reduction, 0·238 per cent.; while experiments quoted a short time back, when on the subject of scrubbing with ordinary liquor, showed a reduction from 0·8 per cent. to 0·6 per cent.—difference, 0·2 per cent.; and further experiments made on a screw condenser, at the Vauxhall station of the Phœnix Company, proved a diminution of from 1·2 per cent. by volume at the inlet to 0·32 per cent. at the outlet, the difference being 0·88 per cent.

It is on this theory of the power of gas liquor to absorb $CO_2$, and, at the same time, to displace $H_2S$, that induced Messrs. Wallace and Claus to take out their patent for the production of caustic ammonia, and the special feature of their process is the employment of a series of peculiarly constructed scrubbers or towers, whereby this "fracticnation," or splitting up of the constituents of the liquor, takes place. The construction of the towers may be described thus—

They are square in form, of a capacity proportioned to the make of gas, the distributing arrangement consisting of a "tumbling box," or angular receptacle, one side of which, being presented to the incoming liquor, is overbalanced, the contents spilled over the receiving surface of the scrubber, and by the same movement the other side is in its turn presented to the liquor, filled, and eventually toppled over.

The interior of the scrubber itself is fitted with layers of angle iron, made with rather an acute angle, and these angle irons are laid each layer transversely across the other. This has the effect of splitting up the liquor into an extremely fine rain, capillary attraction being overcome by the transverse arrangement of the angles. A glass door let into the side of one, by the patentee, revealed the rain-like drops when the apparatus was at work.

In these towers the "fractionation" of the liquor takes place by the action of the incoming gas, the $H_2S$ being expelled to be absorbed by subsequent towers. For the sake of illustration, we will assume five groups of towers are erected, consisting of three to each group. The reason the group arrangement is preferred is, in case the reaction is not complete in the first tower of the group, the second or third tower of the group will complete the action, and thus the liquors be kept separated.

The gas passes through the sieves from 1 to 5, while the supply of the necessary water is pumped to meet the gas in the contrary direction, from 5 to 1, so that by the time it arrives at group No. 1 it is converted into moderately strong liquor, or a mixture of sulphide and carbonate of ammonia. This liquor is pumped for some time up and down group No. 1, so that, by contact with the $CO_2$ contained in the crude incoming gas, its $H_2S$ is displaced and pushed forward to group No. 2, where it is met by the liquor pumped backward from group No. 5, and re-absorbed as sulphide of ammonia. On the contents of group No. 1 assuming the desired form of carbonate, or preferably bicarbonate of ammonia, they are withdrawn and subjected to heat in a suitable vessel, at a temperature of 180° Fahr., and the ammoniac carbonate is driven off in a vaporous form, and condensed in a concentrated state in another vessel. The residual liquor, after the carbonate of ammonia is driven off, is principally water containing a small quantity of carbonate and sulphocyanide of ammonium, and this may be re-introduced into the last series of scrubbers.

The concentrated ammoniac carbonate is then mixed in another suitable vessel with an equivalent of common salt—chloride of sodium (Na Cl), $NH_3 CO_2 + Na Cl = NH_4Cl + Na O_2 CO_2$. Chloride of ammonium and carbonate of soda are formed. This carbonate of soda, being soluble, would be difficult to obtain as such; but recourse is had to its conversion into a bicarbonate by the addition of an equivalent of $CO_2$ pumped into it, and bicarbonate, being insoluble, is immediately thrown down. This $CO_2$, in the first instance, is obtained from an extraneous source, but the bicarbonate of soda once formed, is eventually heated, and the equivalent of $CO_2$ given off is again stored for future use. The bicarbonate of soda

is separated from the chloride of ammonium by a centrifugal pump, or by filtration. The ammoniac chloride is then heated in a boiler with slaked lime, with the formation of ammoniacal gas, chloride of calcium, and water.

$$NH_4Cl + Ca\,O\,HO = NH_3 + Ca\,Cl + 2\,H_2O$$

The calcium chloride, representing the whole of the lime used, is withdrawn in the soluble form, and may be used for sanitary purposes as a disinfectant.

The ammonia gas is absorbed by water as liquor ammonia, or is pumped back in the gaseous form into group No. 3 to effect primarily the removal of the $H_2S$ pushed forward from the preceding groups, and secondarily, the removal of the sulphur compounds; while a plentiful supply of water entering the last of the series will wash out any free $NH_3$ carried forward by the passage of the gas.

Such is an outline of the process for the manufacture of caustic ammonia it has been my endeavor to make intelligible in a few words; and when we think of the efforts that have been made to produce caustic ammonia, we are impressed with the importance of any process which bids fair to remove the difficulties that have hitherto been in the way of success, and for the production of bye-products, which are themselves of great practical utility and a source of wealth.

Of the chemical part of the operation there can be no doubt, for it is simply an adaptation of the ammonia-soda process now in active work on the Continent, although comparitively little known in England, whereby no less than 1,000 tons of carbonate of soda are produced weekly, one firm alone making 400 tons per week, and this firm is enabled to send its products to the very doors of the most favorably situated alkali makers in Germany, and there undersell them in spite of a heavy import duty. It is, however, to the "fractionating" process in the scrubbers that we must turn our attention, and being granted the fact that $CO_2$ is continually pushing forward the $H_2S$, I think this may be comprehended if we imagine an ordinary tall scrubber cut into three portions and placed side by side. In the first section, representing the bottom or inlet of the scrubber, we should probably find the liquor principally carbonate or bicarbonate of ammonia; in the recond portion, representing the middle of the scrubber, the liquor would be a mixture of sulphide and carbonate; while in the third portion, representing the top of the scrubber, the liquor would be nearly all sulphide, and thus the liquors from each portion be kept separated. Whereas, were the portions of the scrubber all on end, making one vessel, the liquors in the various states of transition would be mixed in a receiving-tank common to all.

And now let us see what we gain by a system of purification based on this plan. First, and all-important, no foul lime; and the lime used for the production of the $NH_3$ would be 20 per cent. less than that required for the removal of the $CO_2$.

All operations being carried on in permanently closed vessels, nuisance is reduced to a minimum. Pumping to a large extent will supercede manual labor. No solid refuse to barge away, but a soluble residue of calcic chloride, useful as a deodorizer.

The $CO_2$ hitherto wasted is utilized for the production of carbonate of soda, at a large profit.

The $H_2S$ is absorbed as sulphide of ammonia, thus yielding sufficient material for sulphate manufacture.

The apparatus consisting principally of scrubbers, there would be great economy of space; and last, but not least, the probable solution of the sulphur question.

It will be urged that by adopting this systems gas works will be converted into hugh chemical works, but this need not necessarily be, for the bicarbonate of ammonia solution could easily be barged to neighboring works, and the liquid caustic ammonia sent back to the gas companies.

I may mention that the ammonia-soda process was patented by Dr. Gerlach, of Kalk, near Cologne, and the process may be seen at work at a factory near Brussels.

The accompanying figures, handed me by the patentees, Messrs. Wallace and Claus, will convey some idea of the enormous profits arising from the manufacture of the bicarbonate of soda.

Assuming the $CO_2$ to be 2·4 per cent. by volume of the gas as it leaves the scrubbers, and $CO_2$ being three times heavier than coal gas, then the percentage by weight will equal 7·2 per cent.

Coal gas gives one-fourth of its weight of gas; so, taking a weight of 300,000 tons of coal, will produce 75,000 tons of gas, therefore the weight of $CO_2$ in 75,000 tons of gas will be about 5,037 tons.

Add the $CO_2$ in the ammoniacal liquor, found thus: The quantity of sulphate of ammonia produced from 30,000 tons of coal will be 3,272 tons, the actual ammonia in which is one-fourth, or 818 tons. Three-fourths of this is in combination with $CO_2$ gas, representing 613 tons. Every 17 tons of ammonia will hold 22 tons of $CO_2$ gas in combination; 613 tons will therefore combine with 793 tons of $CO_2$ gas, and the total $CO_2$ in the gas will be $5,037 + 793 = 5,830$ tons.

To produce 54 tons of carbonate of soda will require 22 tons of carbonic acid, so that the 5,830 tons of $CO_2$ would produce 14,310 tons of carbonate, worth £10 per ton = £143,100.

The cost of manufacturing a ton of soda would be—

| | | | |
|---|---|---|---|
| Fuel | 1 | 0 | 0 |
| Labor | 1 | 0 | 0 |
| Salt | 0 | 15 | 0 |
| Wear and tear | 0 | 2 | 0 |
| Total | £2 | 17 | 0 × 14,310 tons |

= £42,215 deducted from £143,100 would yield a profit of £100,885.

In conclusion, I thank you for your indulgence to so long a paper, but I plead the importance and advantages of a process by which we may not only reap great benefits ourselves, but earn the gratitude of the capricious public, and even be in the enviable position to offer a sop to the sanitary Cerberus, who will henceforth be able to flush his sewers and water his streets with tons of deodorizing matter, and render our towns as healthy as the famed "Hygeia" itself.

On the suggestion of the President it was agreed that the discussion on Mr. Marshall's paper should be postponed until after the reading of one by Mr. F. Livesey.

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WEDNESDAY, JUNE 19.

Mr. F. LIVESEY read the following paper on

SOME EXPERIMENTS WITH AMMONIACAL LIQUOR AS A PURIFYING AGENT.

In working out the experiments of which this paper is a description, I have felt that the subject is not in sufficiently competent hands to give the question the thorough investigation it deserves. It should properly be dealt with by a gas maker who is also a clever chemist. I hope, however, the experiments I shall bring before you may be of use, and that perhaps they may lead to some useful results.

It has often been expressed that the purification of gas will ultimately be accomplished in closed vessels, by means of the ammonia produced in the carbonization of the coal, and many attempts have been made in this direction without much success.

There is, however, this satisfaction, that all attempts made bring some further knowledge to bear on the subject, and so help on this much to be desired object. One chief obstacle in the way to this end is that the quantity of ammonia produced is only sufficient to purify about one-sixth part of the gas, so it seems necessary to use the ammoniacal liquor some six times over, being subjected to a purifying process after each successive operation.

Lime, if used in a proper manner, will purify gas from sulphuretted hydrogen ($H_2S$), carbonic acid ($CO_2$), and the greater portion of the sulphur compounds, and as there are many points in common in the chemical affinities of lime and ammonia, it is only to be expected that ammonia would do similar work to lime.

To remove the sulphur compounds lime must be in the form of sulphide, and the gas must be free from $CO_2$. These conditions were formerly considered sufficient; it is now, however, certain that $H_2S$ in appreciable quantity interferes materially with the power of the sulphide of calcium to absorb the sulphur compounds.

Now, there is little difficulty in taking out the $H_2S$ and $CO_2$ by means of the ammonia present, if in sufficient quantities; but to take out the $CS_2$ becomes the difficulty, for a foul liquor must be applied to a comparatively clean gas, thus making the gas once more foul by taking up $H_2S$ and $NH_3$ from the liquor, and so rendering purifiers and scrubbers again necessary.

Lime when carbonated, is of no use for taking out the sulphur compounds, and it is the same with foul ammoniacal liquor, which is generally half carbonated when applied. A sulphide of ammonium is a difficult liquor to produce in ordinary gas making, and, when made, difficult to apply, for the reason I have mentioned before, and also because it so readily gives up its ammonia to a clean gas. Where one impurity can be driven forward from foul lime—viz., ($H_2S$), by $CO_2$, from foul liquor the gas will carry forward three—$H_2S$, $CO_2$, and $NH_3$.

These reasons seem to me the cause why ammonia has not yet effected the entire purification of gas.

That ammonia will, and does, accomplish much in the purification is well known, and these experiments have been made with a view to get the greatest amount of good out of it.

If sulphide of calcium is applied to the action of gas containing $CO_2$, it will ultimately become more carbonated as the contact is continued, and with ammoniacal liquor it is much the same, thus leading to the conclusion that by long contact with the gas a greater proportion of $CO_2$ will be removed, while with a short contact and a weak liquor $HS_2$ will chiefly be taken out. Taking into consideration that the gas liquor is used in the earliest stages of purification, it is unquestionably better to get rid of the $CO_2$ by its means than by lime, and it seems better to work the liquor with that object in view. No plan, I believe, of working gas liquor will take out the $CO_2$ so effectively as a purified liquor, or certainly not in sufficient quantities to do away with the necessity for $CO_2$ boxes.

It will be found that every ounce strength of ammonia in gas liquor equals 0·347 oz. of absolute ammonia, which will combine with 416 cubic inches of $H_2S$ to form sulphide of ammonium $(NH_4)_2S$, or with 414 cubic inches of $CO_2$ to form carbonate of ammonium $(NH_4)_2CO_3$; so that every ounce strength of $NH_3$ in the liquor should show, if entirely combined, some 416 cubic inches of impurities.

[Two tabular statements were printed and circulated among the members, which we hope to give at a future day.—Ed. A. G. L. J.]

Table No. 1 gives an analysis of gas liquors from the different condensing and purifying apparatus. Column No. 1 shows the number of cubic inches of $H_2S$ per gallon; No. 2, the number of cubic inches of $CO_2$; No. 3, the total number of cubic inches of impurities; No. 4, the total number of cubic inches per ounce of strength: No. 5, the strength of ammonia. Table No. 2 is for the purpose of showing the work done by the liquor in passing through either washer or scrubber, as the case may be. The first column shows cubic inches of $H_2S$ removed per 1,000 cubic feet of gas; the second column, the amount of $CO_2$; and the third column, the two combined. The fourth column, which shows the work done, gives the cubic inches of impurities removed per 1,000 feet of gas for every ounce of strength the liquor increases in passing through the vessel. The next column shows the quantity of liquor used per 1,000 feet of

gas, and the last two columns show the ammonia strength.

In estimating the amount of work done by any liquor, the state of the gas must be taken into account; for if the gas is comparatively clean, the iquor will not do so much work. It will be noticed that the best results, in regard to removing the greatest quantity of impurities, are gained by the use of an excessive quantity of liquor.

In experiment No. 3 in the table, as much as 10,797 cubic inches of impurities were removed per 1,000 feet of gas; but to obtain this effect 8·4 gallons of liquor were used for the same quantity of gas, being about three times the total quantity of liquor produced from the gas. I, however, judge from this and other experiments that, by the use of a large quantity of liquor, $H_2S$ will be most easily removed; a longer contact being required for the combination of $CO_2$.

Experiment No. 5 shows this: A washer was filled with liquor, being equal to about half a gallon to every 1,000 feet of gas passed through. The same liquor was left in the washer 24 hours. The liquor in this case removed more $CO_2$ than in the previously mentioned experiment. The gas being in both cases in the same state of foulness. If, therefore, you could leave gas liquor in a washer without increasing its strength, it would ultimately become carbonated to somewhat the same extent as a lime purifier.

The hydraulic main liquor contains, as other analyses have shown, the largest proportion of fixed salt; the condenser liquor the next largest proportion, and the scrubber and washer liquor least. Here are a few examples:—

| | Acid Test, Oz. | Distilled. | Twaddel Doubled. |
|---|---|---|---|
| Hydraulic main liquor ..... | 3 | 5½ | 4½ |
| Condenser " ..... | 6½ | 7½ | 3½ |
| " " ..... | 6⅔ | 7¾ | 4¼ |
| Mann and Walker's scrubber..... ..... | 19 | 23½ | 21 |
| Liveseys' scrubber-washer iquor..... | 11 | 13½ | 2½ |
| Ditto..... ..... | 13 | — | 6 |
| Hill's purified liquor..... | 5 | 6 | 0 |
| " " ..... | 6 | — | 1 |
| " " ..... | 10 | 11 | 2¾ |

The last column shows most conclusively that Twaddel's hydrometer is of no use for indicating the strength, and more especially will the discrepancy be noticed with purified liquor, the first on the list of that class showing a 6-oz liquor to have no strength, this particular liquor containing little or no $CO_2$.

My conclusions as to the best way of working gas liquor are as follows:

Should it be required to make the best use of the liquor, in the ordinary way of working, one point certainly to be remembered is to pass the condenser liquor through some efficient washer or scrubber, as this liquor has not generally above two-thirds its proper quantity of impurities. Analyze the liquor, to see if it contains its proper complement for its strength, and if it does, there is little use in working it over and over again, unless it is convenient to concentrate it for purposes of carriage.

To use the liquor for the removal chiefly of $CO_2$ seems to be rather a difficulty, for by keeping it in long contact with the gas, though more $CO_2$ is removed, less purifying work is done.

The best purifying results, however, both as to $H_2S$ and $CO_2$ are obtained by bringing the gas produced from a certain quantity of coals into contact with from three to six times the quantity of liquor produced from the same quantity of coals, and at the same time subjecting the liquor to a continuous purifying process; or, in other words, the great thing desired is more ammonia. This, of course, means a large liquor purifying power, which is, however, in most cases, easy of adoption. Whether the purification of the gas will be improved by concentrating or distilling the ammonia is still an open question, for when strong ammonia is used that impurity is so readily carried forward. To use gas liquor for the removal of the sulphur compounds seems to be a very difficult matter, for these reasons—The gas must be comparatively pure from $CO_2$, $H_2S$, and $NH_3$; the first two gasses, because the ammonia will not react upon the sulphur compounds in their presence, and the latter must be removed in taking out the two former. So that here is the gas, once purified, to be made quite foul again, and so render necessary a duplication of all purifying apparatus.

The mere record of experiments in the form of tables is not an interesting subject to read a paper about, and I must therefore ask for your indulgence if it has proved somewhat tedious. If this has been the case, it is not the fault of the subject, which is both useful and interesting, but of the writer, who is anxious to have his conclusions sifted by your criticisms.

Mr. Hunt (Birmingham) said the members were much indebted to Mr. Marshall and Mr. Livesey for their papers. The subject of liquid purification was one of immense interest to gas manufacturers, and any information given with regard to it ought to be well discussed. With reference to Mr. Marshall's paper and the Hills decarbonating process, as practised by Mr. Livesey, he hardly understood the conclusions at which he had arrived. He stated that the liquor, after having been treated as Mr. Livesey did, contained very little free ammonia, and that was hardly consistent with the fact that the ammonia so treated took up a certain amount of sulphuretted hydrogen, and also that there was such a proportion of sulphuretted hydrogen and carbonic acid liberated. So far as he had been able to study the subject, Mr. Hill's process offered, for the present, the most practical solution of the question. With reference to the process patented by Messrs. Wallace and Claus, the figures presented were certainly very tempting, and ought to induce them to give great attention to it; but in order to arrive at those satisfactory results, the ammonia-sulphur process being such a success as had been stated, they were asked to introduce into gas works an entirely new chemical process, which required really separate treatment and separate management. The difficulty was not with regard to the treatment of the carbonic acid and the sulphuretted hydrogen, it was to obtain the source of fresh ammonia. There was nothing really new in Messrs. Wallace and Claus's process with regard to the scrubbing, but simply with regard to the supply of ammonia, and there was the difficulty. If they could show that their process was practicably workable and profitable, he had no doubt it would be speedily adopted.

Mr. Gore said Mr Hunt had touched on an important question in connection with the application of liquids to purify gas, and had asked a question which he could answer—namely, how were they to provide the ammonia in the form in which it should become applicable to purifying purposes? It was the misfortune of managers, abroad especially, to have great difficulty in getting rid of their residuals, and ammonia water was one of the greatest bugbears a manager abroad could have to contend with. Now, in dealing with the products some years ago in Valparaiso, his attention was drawn to the use of ammonia for purifying purposes, and to a way in which it could be applied. He had a process by which it could be converted directly from the gas liquor into caustic ammonia, and he found it eventually so profitable that he gave up its use as a purifying agent and sold it to the silver reducing companies for the purpose of reducing silver from ores. He contended that the production of these compounds from the residuals was to all intents and purposes a branch of a gas manager's duty. It was simply following out the principles he ought to act upon in dealing with the ingredients which he was brought in contact with in manufacturing gas. All coal contained certain elements. He dealt with one class in manufacturing gas, and why should he not extend this skill and knowledge in dealing with that which came afterward. If that were done it was quite evident that, if gas men would bring that amount of knowledge to bear upon these residuals which they did in the manufacture of gas, in that proportion would they extract the benefits their residuals were capable of rendering. He held that they had thrown away for many years that which they ought to have used from the commencement, or at least since they ascertained its value for the purpose of extracting those impurities which everybody cried out against. Whether they adopted the process which he believed to be most simple and efficacious—that proposed by Mr. Hills—or that latter one, in which they converted the carbonic acid of the gas into carbonate of soda, or in whatever other form it was done, it was their duty to search for the best means by which they could accomplish the work they had to do, and carry it on to the best results.

Mr. Edwards (Taunton) asked what relation did the quantity of salt first used bear to the quantity of bicarbonate of soda produced for sale? It appeared to him that the cost of the salt would be a great item in the calculation.

Mr. George Anderson said they had had that day a new chapter from an old book. It was some years ago since he asked them to look at washers, when they were all afraid of them; and some years since he spoke of the purification of gas by the ammonia contained in it, and he was glad to see scientific men, who understood a great deal about chemistry, were trying to accomplish this. He did not think, however, that it was entirely a chemical question, because they had had, for a series of years, scrubbers and washers of various descriptions, which had done a great deal of good to the gas, but did not sufficiently remove the impurities which they were put there to take out. His belief was that the reason why any impurities were left was that, first, the materials employed were not chemicaly correct, and next, the mechanical appliances were insufficient. It was difficult for him to speak on this subject, because he was interested in it; but he would not blow his own trumpet more than he could help. He had seen last winter a scrubber worked at the Vauxhall station of the Phœnix Company, and Mr. Marshall was acting as a chemical expert in testing its action. He had had the privilege of being there several days in succession. and he found that that gentleman applied, at the outlet of the scrubber, a slightly reddened litmus solution, and the gas passed through that continuously for several days without showing a trace of ammonia; but there was nothing running into the scrubber, for the purpose of removing the ammonia, but a little clean water to the extent of about 12 or 14 gallons per ton. Therefore it seemed to him that it was the want of mehcanical arrangement which permitted any of the ammonia to go forward in their scrubbers where water was used In the scrubber to which he referred the gas was divided up into the very smallest particles, and by bringing it so intimately into contact with the purifying material, the whole of the ammonia was extracted. Mr. Wallace had spoken to him about this, because he also had seen the action of the scrubber, and he intended to use that in preference to the one shown in the diagram, with reversed angle irons. He had little doubt but that if well purified Hills's liquor were used through a scrubber such as he mentioned, you would get all the different grades of the liquor necessary to produce the result shown on the diagram. In this case the water went from the one to the other; in the scrubber to which he referred there were five vertical divisions, each a water-tight tank doing its own work, and the water passing from the upper to t e next, and so on until it came to the lower one. Another thing he should like to mention, although he knew it was treading on dangerous ground. He regretted that the gentlemen who had read papers had never once mentioned the name of Mr. Patterson, and they would not find a chemical paper on gas five years old without such expression in it. There were members who seemed not to know—although some went instinctively in the proper direction—the great necessity of removing carbonic acid from gas before beginning to

purify it from sulphuretted hydrogen and other sulphur compounds. It appeared to him, and he had studied the subject for 15 years at least, that they were indebted to that gentleman for a very beautiful discovery, and he thought they ought to acknowledge or dispute it. The next point was, supposing you could, with Hills's liquor, get rid of carbonic acid, which was the dificulty—for the papers said that the liquor still contained a certain amount of carbonic acid—it was quite possible to remove the whole of the carbonic acid from gas by lime, and without producing any smell. If you could not do it in that way, you could not do it in large works in towns. He contended you could remove the whole of the carbonic acid, and the lime had no smell a yard off the purifiers. It was then a question simply of removing the waste lime containing the carbonic acid, which did contain at one time sulphuretted hydrogen, but which had all been driven off, and was now simply carbonate of lime. He would ask any gentleman who had anything to do with the subject to let liquid purification engage their attention most, because it would be self-acting, and would save them all a great deal of trouble, and bring about the days so beautifully described, when they would have so much healthfulness and economy.

Mr. George Livesey said there were one or two statements made by Mr. Marshall which were not quite in accordance with his experience, especially that to which Mr. Hunt alluded, that by Hills's process of purifying ammoniacal liquor, you did not purify the liquor. Mr. Marshall stated that all the ammonia was combined, but he did not say to what extent it was combined. As his brother's paper had shown, it might be combined with 400 cubic inches of impurities per gallon; but if 40 inches only were combined, it still might be said to be combined, although to a very slight extent He did not suppose one portion of ammonia would be absolutely combined to its fullest extent, and all the rest in its free state; but the whole ammonia in the purifying liquor was combined with a small proportion of impurities instead of a large proportion. It was quite possible to deprive the ammonia of all its impurities, as he had seen over and over again, only it was not advisable to do so. It required a longer process, and it was cheaper to deprive the ammonia of three-fourths of the impurities, and so to work it over an extra turn, than to deprive of the whole and work it not quite so often. It was merely a question of economy. As to the only way of purifying liquor by lime, as Mr. Marshall said, he was quite satisfied you could make rough caustic ammonia by the process he was using. Now came another difficulty about the scrubbers. He had never been able to get clean carbonate of ammonia. Retain the liquor in contact with the gas as long as he pleased, one, two, three, or four days, the whole of the sulphuretted hydrogen would not be expelled. He had found that they had put 10-oz. liquor into a purifying vessel, and the liiquor contained, say, 1,200 cubic inches of sulphuretted hydrogen to the gallon, and a like quantity of carbonic acid; they had kept that in contact with gas for 48 hours, and its strength was increased from 10 to something like 30 oz., but the sulphuretted hydrogen had still remained at about 1,200 cubic inches to the gallon, whilst the carbonic acid had increased to upward of 10,000 cubic inches. Still they had never succeeded in driving off the whole sulphuretted hydrogen. That might be explained in this way. It was not as if you had an obsolutely pure substance to deal with. Would-be chemists often assumed that they were dealing with a simple substance instead of, as they were, with one of the most complex substances possible to find. The gas containing not only carbonic acid, but also sulphuretted hydrogen, being brought into contact with this liquor, was continually bringing a fresh increment of sulphuretted hydrogen to the liquor, and he could easily understand that sulphuretted hydrogen would always be present. If you brought carbonic acid only in contact, you might drive off the whole of the sulphuretted hydrogen, as had been proved in some experiments which he had tried. They purified the liquor by bringing it into contact with waste gas from the furnace, containing a large quantity of carbonic acid and no sulphuretted hydrogen, and deprived that liquor absolutely of every trace of sulphuretted hydrogen, so that it could not be detected by lead paper. But then came this extraordinary circumstance: The liquor which had been deprived of all carbonic acid when put into a scrubber, took out all the sulphuretted hydrogen from the gas. That was an absolute fact. It was an incredible fact, and he had never had it explained; but it was a certain fact that the whole of the gas for six months was purified from sulphuretted hydrogen by this highly carbonated liquor. He was afraid, unless something extraordinary was realized from Mr. Wallace's arrangement, they could not expect to get pure carbonate of ammonia. As to the profit, it reminded one of the old estimates of Mr. Winsor, about a profit of 9d. per 1,000 feet for gas sold from the carbonic acid utilized They could reduce the price of gas to about 2s. per 1,000 feet, and still pay good dividends. All he could say was, he should be very glad to see it, but he was afraid there was some element omitted. It was said that there was about 2½ per cent. of carbonic acid in gas as it left the scrubbers, but he did not find that; and other engineers with whom he had conversed informed him they did not find anything like so much as that after the gas had been properly washed. With regard to his brother's paper he did not wish to say much. The tables would be found interesting, and the points to which special attention might be drawn were the quantities of impurities that the liquor would absorb. He did not think his brother wished to disparage, in any way, Mann and Walker's scrubbers, when he said he had not divided that by ounces, as ascertained by the distillation test. Still there was this fact, that they had not nearly enough ammonia to purify the gas, and if they had to use it, they must use it five or six times over. He was inclined to believe it would answer the purpose to do so, but at any rate he was quite satisfied it could be done. There was one other difficulty in using caustic ammonia: it was such an exceedingly volatile article, when in the caustic state, that the gas carried it forward, and the great difficulty was to keep it in the purifying vessels. You put lime into a vessel, and there it stopped until you took it out, but you might put caustic ammonia in, and when you looked for it it was gone; and you must use a large quantity of water to prevent the ammonia being carried forward. Mr. Hammond told him of a process of his in which he applied the ammonia to the hot gas immediately on leaving the hydraulic main. In that state the caustic ammonia combined with the impurities before it reached the scrubbers, and was washed out in the ordinary way. That seemed to be a promising way out of the difficulty. Still he was in good hopes that they should see light in this matter before long, and these experiments were all tending in that direction.

Mr. Hunt said he did not intend to imply that it was not quite possible to obtain perfectly clean carbonate of ammonia in the first vessel, but he did not think it either desirable or necessary for Mr. Wallace's process. There seemed to be no difficulty whatever in eliminating the whole of the carbonic acid and sulphuretted hydrogen by the ammonia process.

Mr. Vernon Harcourt wished to put a question to Mr. Frank Livesey. The chief value of the process seemed to be not the removal of the sulphuretted hydrogen, which could not be better done than by oxide or iron, but the removal of the carbonic acid. The important service which this approximately purified ammonia could render was that of removing carbonic acid. There was a great chemical advantage in using that over lime, because the quantity of ammonia which would remove a given quantity of carbonic acid could be produced much cheaper by this process than the quantity of lime which would remove the same amount. He wished to ask, however, whether it was found that, by the adoption of this process, it was possible at the South Metropolitan Gas Works, to remove the carbonic acid from the gas as effectually as before with a smaller quantity of lime? That, he thought, was a measure of the value of the process as now used. One word with reference to what Mr. George Livesey stated as an almost incredible fact: It certainly did not seem to him to be even surprising. If you took a solution of carbonate of ammonia and shook it up with sulphuretted hydrogen, you formed sulphide of ammonium, and set free carbonic acid. If, on the other hand, you took a solution of sulphide of ammonium and shook it up with carbonic acid, you formed carbonate of ammonia, and set free sulphuretted hydrogen. The fact was that the condition of the outlet would always resemble the condition of the gas which was mixed with it, or passed through it. You could increase the proportion of carbonic acid, and decrease the proportion of sulphuretted hydrogen; but you would always have, if the gas contained both, some of both gases in the solution.

Mr. Chandler said he was no chemist, but rather followed in the footsteps of Mr. George Anderson, and he might just make a statement with regard to the effect at the Bromley station. Mr. Marriott was conducting experiments with this solution for the purification of gas from sulphuretted hydrogen and carbonic acid, but he omitted to state the vessel in which Mr. Marriott was conducting this experiment. The apparatus in which this Marriott's solution was being tried was known as Kirkham, Hulett, and Chandler's washer. This vessel, like his, had a number of divisions It was a horizontal vessel, 17 feet long, divided into ten different bays, each of which was charged with water to start with, and as the gas passed through the water became strong liquor.

The President, interposing, said they were discussing the principles of the papers read, not the details of different scrubbers.

Mr. Hammond (Lewes) said he had recently distilled some caustic ammonia, and brought some in a bottle, and if any gentlemen liked to examine it they could do so. It was readily produced by the process he had in work at Lewes. He not only took the crude ammoniacal liquor from the well and distilled it for the caustic ammonia, but he afterward recovered the ammonia by washing in suitable vessels, and made a marketable product in the shape of sulphate of ammonia. The process was very effective for the removal of carbonic acid and sulphuretted hydrogen.

Mr. Anderson asked if Mr. Hammond used lime.

Mr. Hammond said he took the crude liquor and put it into boilers, and drove off the foul gases—carbonic acid and sulphuretted hydrogen to a very great extent—through acid in a closed saturator. He made a certain amount of sulphate of ammonia by the process, then shut the valves, and had a closed iron vessel capable of resisting great pressure, into which he drove high-pressure steam. That expelled the air contained in the vessel. Then he mixed cream of lime in a tub, shut the steam from the iron vessel, and produced a vacuum which sucked from the top of the tub the cream of lime. The sediment was not drawn over, but the cream of lime alone, which mixed most readily with the water. High-pressure steam was again turned on, and the whole of the contents blown directly into the crude ammoniacal liquor with which he started. Then he opened a tap and passed the gas, not again through the saturator, but through an apparatus to regulate the temperature, and from that it passed direct to the hydraulic main, at the extreme end. He could put it into the extreme end of the hydraulic main, either in the form of a vapor or liquid, to mix with the gas; it flowed readily past each dip-pipe, and mixed with the gas as it passed out. He produced a bottle of the liquid, obtained directly from the apparatus before it passed away with the steam into the hydraulic main; also a bottle of the liquid taken out from the hydraulic main, the valve of which had been broken.

Mr. F. Livesey said that, with reference to Hills's liquor, it was very evident it would do the work. The liquor, before it was purified, contained 2,076

cubic inches of $H_2S$, and 867 afterward. The carbonic acid was 2,002 cubic inches before and 489 after, showing that the carbonic acid was reduced one-fourth, and sulphuretted hydrogen to less than one-half. Mr. Anderson had referred to Mr. Patterson. They all knew Mr. Patterson did make a discovery that lime would not work unless carbonic acid was absent, and this was so well known that he thought it hardly necessary to mention it. It was also found it would not work when sulphuretted hydrogen was present; it would not take out the sulphur compounds if that gas was present in large quantities. Mr. Vernon Harcourt asked a question about the carbonic acid after passing through the washers. They had found there was about one-half per cent., and something less, of carbonic acid, and by that means they were able to do away with the carbonic acid boxes. After the washers the lime, which the gas came in contact with, acted as sulphide to remove the sulphur compounds. If they did not use Hills's liquor they would require carbonic acid boxes.

Mr. MARSHALL said they were working with Marriott's process with an ordinary 24-inch pipe filled with coke, and they had very good results. With regard to Mr. Anderson's observations, he quite agreed that this process was not entirely a chemical one—in fact, in his paper he had drawn particular attention to the mechanical portion. The angle plate was not a patent, and was open to any one who liked to adopt it. Mr. Anderson also said he used the litmus solution at the outlet of one of his washers. That was the ordinary process, and he found good results. He was sorry he had missed naming Mr. Patterson, but his name was well known. With regard to Hills's process, they might discuss that for all time, but he was in a position to give an analysis of the figures obtained from a boiler where it was under trial, and the results of his experience were these: If the liquor was not heated up to a certain temperature, the action would not take place causing separation of carbonic acid, ammonia, and sulphuretted hydrogen. If you heated it a little more, the action did take place to a certain extent, but the washing power or condensing power required to condense the gas again to the normal temperature was very great; but in the samples that were taken the ammonia existed in the free state only to the amount of ·01024, and the rest as sulphide and carbonate of ammonia. In the face of these figures, he maintained that the action was not complete. Again, admitting it was complete, and that it did drive the carbonic acid into the carbonate of lime, would they be able to dispose of it? There was no carbonate of lime in Mr. Hills's process. The sulphuretted hydrogen was driven forward as oxide; in this the compounds of ammonia as sulphide of ammonia were used for taking out the bisulphide of carbon compounds. Mr. Harcourt's observations were somewhat similar to Mr. Anderson's, that it was not a chemical but more a mechanical change they had to turn to. Mr. Gore only told them what they already knew—that they must work up the compounds; and any gas companies who wanted to go into this operation would no doubt put in a clause which would enable them to start chemical works. But they need not do so; they could sell the products to chemical works. Mr. Hammond's process appeared very feasible, but he used milk of lime, and got carbonate and sulphide of calcium in the same degree, and this was most voluminous and most difficult of disposal. What they wanted was a process for doing away with the liquid sulphide of calcium, and only getting products which would be useful. As to looking at this matter only in a chemical point of view, he was not a chemist, but a gas maker, and he really found that chemists where the most unpractical men. With regard to Mr. Hammond's observations that the first tower contained a mixture, and that the gas coming into the scrubber contained sulphuretted hydrogen as well as carbonic acid in considerable quantities, that might be so until you got a pump, when you would displace the sulphuretted hydrogen. These experiments showed that over and above the sulphuretted hydrogen driven off there was 0·66 of free sulphuretted hydrogen left in the liquor drawn from the first tower; and it was not in combination, but existed chemically in the free state. Supposing the decarbonated ammonia did contain sulphuretted hydrogen, it would not matter, because on being placed into the water-tight vessel whereby the carbonate of ammonia was driven off, you might so arrange the condensers that sulphate of ammonium would be condensed in the first vessel, and the carbonate of ammonia driven forward in the last series, so that from them you could draw off the carbonate of ammonium, take up the sulphate in the first, and pop that back again to the gas, so that you would have no smell and no loss of sulphuretted hydrogen. As regarded the desulphurating liquor boxes patented by Mr. Livesey, there was no doubt the hot furnace gases would so warm up the gases that the amount of power required to cool the furnace gas would be a considerable item in the expense, and there would be the objectionable carbonate of lime to deal with. The profits did seem enormous, but they were given by the inventors, and when they came to look at the amount of carbonate of soda sold, he did not think they would be found very excessive.

The PRESIDENT said he should like to have said a few words with reference to these papers, not so much with reference to the particular process, which had been very lucidly explained by Mr. Marshall, as on the general question of purification by liquids. But he felt that any observations he could make would not outweigh the consideration that they had very much more work to do, and as there were several papers yet to read, he would not detain the meeting.

## New Gas-Testing Cock.

It is remarkable that in these days of exactness in science and manufacture no means are usually taken to observe the temperature of gas in the mains of gas works with sufficient accuracy. The usual method is to fit a pocket or shell into the main-pipe, into which is occasionally dipped a thermometer fitted to a conical plug which sits in the opening of the pocket. The gas itself does not come into contact with the bulb of the thermometer at all, but its heat is transmitted through the metal of the shell to the column of air contained therein, so that the temperature registered is really that of this column of air. Other facts concerning the gas, such as the presence of sulphur and ammonia, are impossible of observation by such an arrangement.

An improved device for this purpose has been patented by Mr. J. F. T. Drory, engineer to the Imperial Continental Gas Company, and is made by S. Owens and Co. The instrument is inserted into Mr. Drory's improved pocket, which is, indeed, truly a cock, inasmuch as it is made of two tubes, one of which turns within the other, so as to admit gas at pleasure through a couple of openings. The tester, having a piece of lead or other test paper attached, is used to plug the inner tube, and a turn of the handle brings the gas into contact with both thermometer and test paper. Another turn the reverse way enables the tester to be withdrawn, and thus the temperature and reaction of the gas are instantly ascertained, from actual contact, and without any escape of gas.—*Iron.*

**Flame Temperature.**—M. Rosetti, of Venice, has recently carried out some experiments to determine the temperature of a Bunsen flame. He used a thermo-electric apparatus. His estimate of the temperature of a Bunsen burner is as follows: Exterior flame, 1350 deg., diminishing to 1200 deg. at the dark central cone; interior of cone, top, 650 deg.; bottom 250 deg. These figures are of the Centigrade thermometer, equivalent respectively to 2462 deg., 2192 deg., 1202 deg., and 482 deg. Fah. The method of obtaining the estimates can, however, give only proximate results.—*Polyt. Review.*

# Correspondence

[We are not responsible for the opinions expressed by Correspondents. Correspondents, in all cases, should sign their communications with their names and address in full—not for publiction, unless desired, but as a guarantee of good faith.—ED.]

### A New System of Charging Retorts.

*Mr. Editor*:—I was pleased to see in your issue of Sept. 16 a communication from the President of the Yonkers Gas-Light Company detailing the beneficial results of drawing and charging the retorts in a setting simply, instead of the whole at once, and of your remarks of approval thereon, with the improved workings shown concisely in candle feet. I think there can be but one opinion as to the advantages of the system as respects both the quantity and quality of the gas produced, and probably to some extent, also, in a diminished consumption of fuel and a saving of lime; but, like almost everything else, the benefits are not, I fear, without a certain alloy, the drawback being the frequent chargings necessary, affecting the stokers in a similar way—although, of course, in far less degree—to that of the pedestrian who walks 1,000 miles in 1,000 consecutive hours. Any one in health could easily accomplish that, being but 24 miles a day, but it is the restriction to only one mile per hour that constitutes the feat.

These remarks, it will be obvious, apply only to small works. In houses containing a large number of retorts, a sufficient number could be charged at a time by taking one each in several settings, allowing a reasonable "spell" for resting between the draws, which experience has long ago proved to be necessary. But even that method has the fault of requiring to move from setting to setting with the drawing hoes and charging scoops (where the latter are used) a disadvantage that will be readily understood.

A plan on the whole perhaps preferable is one that I publicly recommended several years ago, and was intended to supply chiefly to small works (as, so far as I am aware, the practice of charging a whole setting at once has long ago been discontinued in all large works), and which it may not be out of place to reproduce here.

"In working it used to be customary to draw and charge a whole bed at once. If this is still done anywhere, it would be advantageous to abandon the practice. The result is the lowering of the temperature of the retorts to a greater degree than when only a part of the setting is charged, and this, too, at the time when it is most required to be kept up. A convenient way is to reciprocally charge half the number in the bed, when the charge in the others is half worked off. There not then being such a rapid absorbtion of the heat by those containing the half-spent charge, the fresh charged ones get the benfit, and thus a kind of self-acting adaptation of the heat to the condition of the charge is effected, and better results obtained. It is true that the injurious effects of charging a whole bed at once does not hold good to the same extent with clay as with iron retorts. Still, it is an evil, and is just one of those apparently unimportant details, the due attention to, or neglect of, which go far toward accounting for the greater or less success of any industrial pursuit.

"There is the less reason, too, for this custom, because its abandonment entails no additional labor or inconvenience, but is, on the contrary, a matter of convenience and comfort. I have understood that Mr. John Kirkham, when engineer-in-chief of the Imperial Gas-Light Company, was the first to adopt this improved method of working."

E. S. CATHELS.

Hamilton, Ont., Sept. 21, 1878.

### A Visit to West Virginia Coal Fields.

SKOWHEGAN, MAINE.

On Saturday, Sept. 22st, agreeably to the invitation of the Coal Agency of the Chesapeake and Ohio RR. of Virginia, some fifty or sixty ladies and gentlemen,

more or less interested in the manufacture of gas, and in the gas men, assembled on board the steamer Old Dominion, at her pier on the North river, for the purpose of visiting the coal fields of West Virginia, and objects of interest on the line of the C. & O. RR. Great care had been taken to invite some of the noisiest among the gasmen, to ensure liveliness, and the entire command of the pilgrims devolved upon Col J. J. Gordon, the well-known representative of that company's coal interests. To say that this charge was faithfully fulfilled is to give no hint of the constant care, self-forgetfulness, and unwearied zeal of that gentleman, to whom all present ascribe the success of the trip. The sail down the coast was delightful, lacking only moonlight to have perfection. Old Neptune was in sunny humor, and gave us summer seas, a thoughtfulness on his part that enabled our party to be in full strength at every meal—a sight that did Capt. Walker's jolly heart good—it also secured the presence of the ladies of the expedition—fair queens they were, who dictated all the comforts and pleasures of the expedition, and by kindly ways and ready participation in all that was doing, soon made the party forget formality and welded it into one large family before the first night had fairly dawned around us. So we fared pleasantly till Sunday evening found us in the Norfolk, where many availed themselves of the delay, in loading and unloading, to visit the city and its gasworks, the latter showing intelligent and careful superintendence. At night, led by Captain Walker, that mild-mannered, genial sailor, a large delegation visited an African Methodist Church, and enjoyed the singing and fervent exhortations, and not forgetting to "remember the sexton."

From Norfolk to Richmond is usually a matter of eight hours by river; but when you take a large steamship, and undertake to "cut across lots," it takes longer, at least such was our experience, as it took us eighteen or twenty hours, as the pilot tried to go by land. Still we did get there finally, and found the "special" train, that was our master for so long, awaiting us. It was awful work to get that "special" started—some Richmond friends, who had *walked down* from City Point to meet us, the previous night, and failed to connect, began to reach town, on their return trip, just as we arrived: the consequence was that in renewing old friendships, and making new ones, the expedition was being continually asked "up the street." Just here Gordon won his crown of martyrdom, he had a hard time controlling us, but did finally get us on the train, and started for Gordonsville and a dinner. Thence, through a charming rolling country, lifting into mountains, or deepening into pretty valleys, we travelled far into the night for the White Sulphur Springs and a bed. Bless me, how I regret your crowded columns, for my pen itches to pitch into that whited sham of a hotel. It is a very Dead-Sea apple of place, fair and tempting without, ashes and emptiness within. The late A. Ward wanted to send all his wife's relations to the army; had he made it to this hotel sure death would have taken them all—but enough.

Morning called us to see how lavish Nature had been in her beautiful handiwork at this spot; and, after astonishing our stomachs with some sulphur water, and a breakfast of doubtful quality, we answered the repeated calls of our impatient "special," and got aboard and started for a day of sightseeing. Gen. St. John, Chief Engineer of the RR. company, took charge of the pilgrims that day, and led us through the wonders of the region—showing coal mines, coke and iron furnaces, and was erewhile patiently explanatory, and gave, in endless variety, a wealth of information and of details that was striking and valuable. It was a sad sight for the gas men to see the coke furnaces turning into the air thousands of feet of "unaccounted-for gas," and they sighingly thought of various holders in which they could imprison it. So we rode through this wonderfully beautiful country, stopping, as fancy dictated, or a washed-out track suggested, here and there, until Cannelton was reached, where an agreeable suprise, in the form of a dinner, awaited us. The coal operators of that vicinity united in the capacity of host, and well did they acquit themselves. Forever after did our pilgrims keep record of time and events by saying, "it was before" or, "it was after that dinner at Cannelton." The hearty welcome, the well-cooked, and neatly-served, dinner, and the addenda of wines, put everybody in good humor, and producer, carrier, and consumer of coal had each a pleasant word to say for the other—thus forever throughout the world does a good dinner, and a bottle of wine, soothe the savage breast of man. Later in the day we visited other mines, and met the ladies who gladden these wilds with their presence, and make refined and happy homes in the wilderness, and felt sorry that we could not prevail upon them to leave the wilderness and come with us. The shades of night were falling fast, as down the hill our party past, got on a boat not over nice—saying this is a sham, a mean device—and crossed the Kanawha river to Charleston, the capital of West Va. I am going to write a volume on hotels some day—when I do just notice the remarks under Hale House. Somebody stole Col. Spalding's coat, while that festive youth was having a colored reaper go over his two-day's stubble, and we had a lively evening chasing the thief. Charles, in a long duster, flew around abusing everybody, from the proprietor to the porter, and the "boys" followed to back him up; the tide of battle ebbed and flowed from office to bar, from bar to piazza, thence to the parlor, where the ladies poured the balm of sympathy upon the coatless Colonel; but he refused to be comforted—like another Rachel, he mourned not his coat, but his note-book that in it was—and, after accusing everybody, from the Governor down, we found the malefactor to be one of our own household—not a gasman, thank fortune, still one of us—a lame and impotent story of an exchange of coats in mistake followed, but none believe it, and we sternly bade the offender to "treat," and marked him as a dangerous man ever after.

The morrow began our return. We felt sorry to leave—the bread was so heavy that we all wanted to stay and get strong enough to lift it. Nature was sorry to see us go, and wrapped the heads of the mountains in cloudy veils, and dripped rain-tears from leaf to leaf of the trees upon the slopes. But later on the sun came out, and gave new beauties to the rugged scenery about us. We spent our time this day in saturating ourselves with the stately grandeur and bold beauty of the rock-ribbed and everlasting hills, whose feet were bathed in the waters of three rivers, while the softest shades of green clothed their rugged sides, leaving here and there gaunt castles of rock bare and gaunt in the upper air. Rolling along in the cars at the base of the mountains, we caught from the car windows odd effects of light and shade. The views shift and change constantly; the mountains seem to close up after us, while before us their giant heads shut out the view, till advance or retreat seem alike impossible; then a hurried rush into darkness, and infernal roar and clatter tell of the tunnel that leads us into freedom and light on the further side. Again a cunningly-devised curve swings us out of seeming danger, or a great "fill" or fairy-like tressel bridges the mountain gorges or crosses the brawling torrents below. All day long, untill the evening's purple shadows drove us in, did we study the book of nature, turning page afrer page only to find new delight in happier blendings of cloud shadows, or richer mellowing of sun tints on the green slopes around us. Autumn, too, hung out her advance banners, and the crimson of the maple and the golden glories of the beach burned red and gold along the higher summits, while summer lingered in the wild flowers, plentiful as yet in the valleys and sunny spots by the roadside. Beautiful and wild, it was a realm of infinite peace we passed through that day; a primeval solitude in which the rattle and roar of our train was a discordant intrusion. And yet, peaceful as it then was, a few days before the river that now smilled and dimpled in sunny pools, or brawled over its rock-fretted rapids, rose in a great flood that for hours swept every vestige of civilization from its banks, and left nothing but wreck to mark its path. The late hours of night found the tired and weary pilgrims at Staunton, where all—except the few who never seemed to sleep, never got tired, and were always willing to go anywhere—gladly went to bed. Your correspondent joined the unwearied, and visited the gas works, and, later yet, rang up a sleepy druggist, that the pangs of one of the party might be assuaged. Bumgardner.

Next day "on to Richmond" was in order, and at 2 P. M. the head of the column reached that hospitable city, and found our friends of the city government, the gas folk, and masonic brethren in force to receive us. We had no lack of attention from our arrival until our departure, and I wish I had space to write what we all felt touching this kindly treatment by our friends. A formal welcome was given to us at the hotel in a very pleasant, hearty speech from Capt. Taylor, of City Councils, and later in the day our party visited, in charge of their hosts, the gas works (presided over by that irrepressible and perennial good fellow, Knowles), the water works, and many points of interest, winding up, for a brief rest and lunch, at the Almshouse. It is not popularly supposed that the gas business leads those engaged in it to such places, the feeling being rather the other way; but there we were, and if the lunch was in truth the leavings from the poor man's table, as the gentlemanly keeper said, why, may we all get there again! On the way to the almshouse the occupants of the three leading wagons in our procession concluded to desert and take in a circus (when I tell you that we had an ice man and a light Frost in one wagon, the coolness of the movement is explained), which greatly interested them. The ground and lofty tumbling of the troup, the flying through the air of the chief trapeze performer, the shortening of curves, and the standing of trick horses on their back bones, eclipsed anything ever before attempted in those lines, and before which common performers may wilt like flowers before a *Frost*. That night is somewhat tangled I know that the masons went to a banquet given them by the Richmond Knights Templar, and that it was awfully jolly; I know that the ladies went to the theatre escorted by the unhappy outsiders, the profane— But subsequent events are mere details, and I always hate details; so let's get to the next day, when, with the break of day, we masons went to bed.

Our last day was devoted to sight-seeing in Richmond. Our tireless friends were on hand, and with them we did the tobacco factories, and grew learned in the mysteries of "twist" and "plug," and watched the deft fingers of pretty girls "roll, cigarettes, roll!" We also visited the capitol, with its valuable library and collection of relics dear to Virginians, and had an audience with Gen. Holliday, the Governor, who, in response to our greeting, bade us welcome and gave us one of the most eloquent little speeches I ever listened to. At 4 P. M., attended by our friends, faithful to the last, we boarded the steamer, and after renewed and re-renewed and hearty farewells, turned our backs upon Richmond, and set our faces toward home. Monday found us recovered from the epidemic of sea-sickness, and landed us in Gotham safe and sound, everyone full of praises of the kinkness and hospitality with which we, who had been as strangers in a strange land, were met and cared for. After a breakfast together and a drive around Central Park, our expedition ended, and became "a thing for memory—a plaything of the past." Doubtless it was with mutual regrets, and, I trust, with deepened ties between old friends and fresh bonds to new, that we parted, and each took up his own round of duties again.

C. A. P.

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**As the Statistics** of fires show that the burning of kerosene causes heavy losses every year, the executive committee of the National Board of Fire Underwriters is considering the expediency of appropriating a sum sufficient to make scientific tests of the various oils in use.—*Herald, Oct. 3d.*

## Gas Stocks.

**Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.**
**(with W B Scott & Co.,)**

24 PINE STREET, NEW YORK CITY.

OCTOBER 16, 1878

☞ All communications will receive particular attention
☞ The following quotations are based on the par value of $100 per share.

| | Capital. | Par. | Bid. | Asked. |
|---|---|---|---|---|
| *Gas. Co.'s of N. Y. City.* | | | | |
| Central | 466,000 | 50 | — | 80 |
| Harlem | $1,800,000 | 50 | 40 | 50 |
| " Bonds | 170,000 | | | 103 |
| Manhattan | 4,000,000 | 50 | 157 | 167 |
| Metropolitan | 2,500,000 | 100 | 110 | 120 |
| " Scrip | $1,000,000 | .. | — | 102 |
| Mutual | 5,000,000 | 100 | 70 | 73 |
| " Bonds, gold. | 900,000 | 1000 | — | 105 |
| Municipal | 1,500,000 | 100 | 90 | 95 |
| " Bonds | 750,000 | | 97½ | 100 |
| New York | 4,000,000 | 100 | 75 | 85 |
| Northern | 270,000 | 50 | — | 100 |
| *Gas Co.'s of Brooklyn.* | | | | |
| Brooklyn | 2,000,000 | 25 | 140 | 150 |
| Citizens | 1,200,000 | 20 | 59 | 65 |
| " Scrip | 320,000 | 1000 | 95 | 97½ |
| Peoples | 1,000,000 | 10 | 20 | 30 |
| " Bonds | $ 325,000 | ... | -- | 95 |
| " Scrip | 300,000 | ... | 75 | 80 |
| Metropolitan | 1,000,000 | 100 | 55 | 60 |
| Nassau | 1,000,000 | 25 | 62 | 65 |
| " Ctfs. | 700,000 | 1000 | 90 | 95 |
| Williamsburgh | 1,000,000 | 50 | 80 | 85 |
| " Scrip | | ... | 95 | 97 |
| Kings Co | 200,000 | 100 | — | 90 |
| Union Co. E N. Y. | | 25 | — | 50 |
| Richmond Co., S. I. | 300,000 | ... | 80 | 90 |
| *Out of Town Gas Companies.* | | | | |
| Bath, Maine | 70,000 | 100 | | |
| Buffalo Mutual, N. Y | 750,000 | 100 | 65 | 70 |
| " Bonds | 200,000 | 1000 | 95 | 100 |
| Baltimore, Md | 2,000,000 | 100 | 100½ | 103 |
| " Ctfs., gold | 1,000,000 | | 101 | 103 |
| Bayonne, N. J | | 100 | | 90 |
| Brockport, N. Y | 25,000 | 100 | ... | 80 |
| Citizens, Newark | 918,000 | 50 | — | 95 |
| " " Bds. | 124,000 | — | 105 | 107 |
| Chicago Gas Co., Ills | | | 150 | |
| Cincinnati G & C Co | | | | 190 |
| Derby of Conn | 160,000 | 100 | 60 | 80 |
| East Boston, Mass. | | 25 | 132 | -- |
| Elizabethtown, N. J. | 300,000 | 20 | — | 130 |
| Fort Wayne, Ind | | 100 | ... | |
| Hannibal, Mo | 100,000 | 100 | 95 | 100 |
| Hartford, Conn | 700,000 | 25 | 184 | 186 |
| Hempstead, L I | 25,000 | 100 | ... | — |
| Jersey City | 386,000 | 20 | 150 | 155 |
| Jamaica, L. I | 25,000 | 100 | ... | — |
| Jacksonville, Ill | 120,000 | 50 | 82 | ... |
| Lewistown Maine | 400,000 | 100 | 70 | 80 |
| Lima, Ohio, | 60,000 | 100 | -- | ... |
| Bonds | 30,000 | | 90 | |
| Laclede St Louis Mo. | 1,200,000 | 100 | — | 75 |
| Long Branch | | 20 | 40 | 50 |
| New Haven, Conn | | 25 | 160 | — |
| Peoples, Jersey City | | ... | — | 100 |
| Peoples of Albany | 650,000 | 100 | 10 | 17 |
| " Bonds | 350,000 | 1000 | -- | - |
| Peoples of Baltimore | | 25 | — | 52 |
| " Bonds | | | 106 | — |
| Plainfield, N. J | 80,000 | 100 | — | 105 |
| Perth Amboy | | 25 | — | 95 |
| Rochester, N. Y | | 100 | 50 | 60 |
| Woonsocket, R. I | 150,000 | 100 | 95 | ... |
| Halifax N. S | 400,000 | 40 | 148 | 150 |
| Hamilton, Ontario | 150,000 | 40 | 117½ | |
| San Francisco Gas Co., S. Fr'isco Cal. | | | 95 | 95¼ |
| St. Louis, Missouri | 600,000 | 50 | 73 | 75 |
| Stillwater, Minn | 50,000 | 50 | — | 26 |
| Saugerties, N. Y | 15,000 | 100 | 95 | 100 |
| Troy, Citizens. | 600,000 | 100 | — | 60 |
| Toledo, Ohio | | | 95 | 97 |
| Washington, D. C | | 20 | — | 200 |

The following gas stocks were sold at auction on the 9th instant—140 shares of Metropolitan, of New York, @ 105—108; 1,900 scrip o same company, @ 99¾; 10 shares of Manhattan, of New York, @ 165, and 57 shares, @ 157; 10 shares of New York, @ 81¼; 200 shares of Brooklyn, @ 138—141; 120 shares of Citizens, of Brooklyn, @ 59; 100 shares of Nassau, Brooklyn, @ 62; $1,500 scrip, of same company, @ 91.

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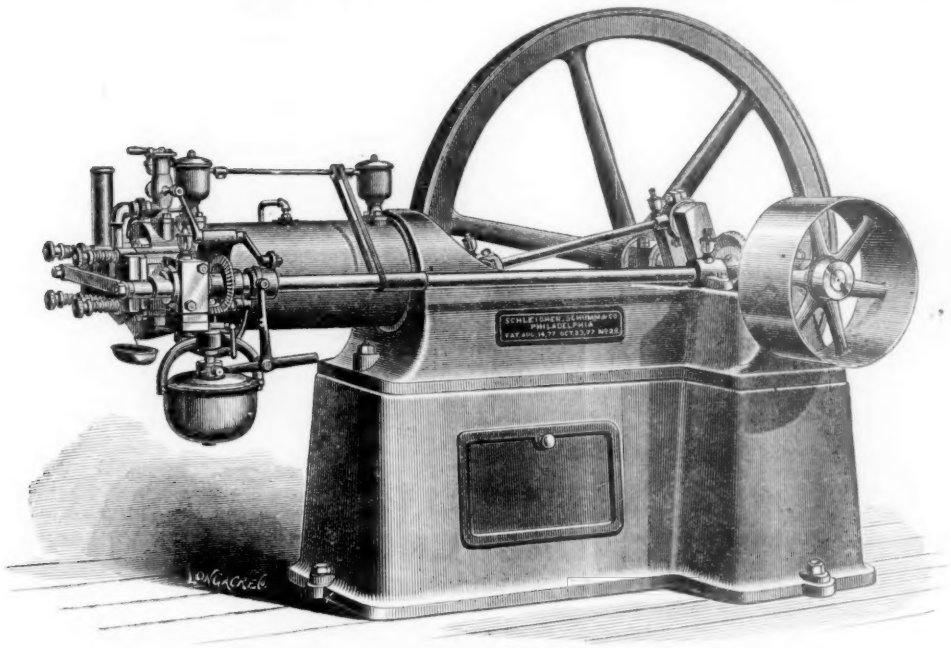

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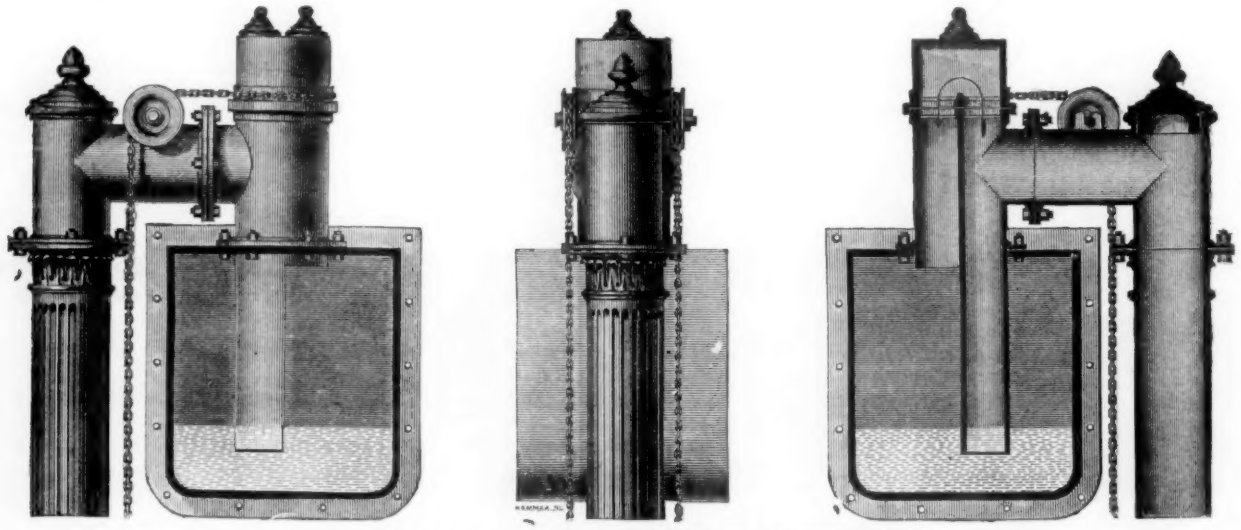

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**General Office—89 Wood Street,**
PITTSBURGH, PA.

**Branch Office—120 Water Street,**
CLEVELAND, OHIO.

WILLIAM A. McINTOSH, President.
A. CARNEGIE, Vice-President.
W. P. DE ARMIT, Treasurer.
THOMAS AXWORTHY. Agent
at Cleveland, Ohio.

351-1y

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THE NEWBURGH

## Orrel Coal Company,

Mines at Newburg, Preston County, W. Va.
Company's Office, No. 52 S. Gay Street, Baltimore, Md.
C. OLIVER O'DONNELL, Pres't. CHAS. MACKALL, Sec'y.
CHAS. W. HAYS, Agent in New York, Room 7, Trinity Building, 111 Broadway.

This Company offer their very superior Gas Coal at lowest market prices.

It yields 10,996 cubic feet of gas to the ton of 2,240 lbs. of good illuminating power, and of remarkable purity; one bushel of lime purifying 6,792 cubic feet, with a large amount of coke of good quality.

It has been for many years very extensively used by various Gas Companies in the United States, and we beg to refer to the Mannattan, Metropolitan, and New York Gas Light Companies of New York; the Brooklyn and Citizen's Gas Light Companies of Brooklyn, N. Y.; the Baltimore Gas Light Company of Baltimore, Md., and the Providence Gas Light Company, Providence, R. I.

Best dry coals shipped from Locust Point, wharves, and prompt attention given to orders for chartering of vessels.

224-1y n

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## THE DESPARD COAL COMPANY
OFFER THEIR SUPERIOR
**DESPARD COAL**

To Gas Light Companies throughout the country.
Agents, PARMELEE BROTHERS, No. 32 Pine street, N. Y.
BANGS & HORTON, No. 31 Duane street, Boston.
Mines in Harrison County, West Virginia.
Wharves Locust Point, } Baltimore.
Company's Office, 15 German St., }

Among the consumers of Despard Coal, we name: Manhattan Gas Light Company, New York; Metropolitan Gas Light Company, New York; Jersey City Gas Light Company, N. J.; Washington Gas Light Company; Portland Gas Light Company, Maine
"*" Reference to them is requested. 204-

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## TYRCONNELL GAS COAL.,
*MINED IN TAYLOR COUNTY, WEST VA.*
**Company's Office, 52 S. Gay St., Baltimore.**
CHARLES MACKALL, Secretary.
CHARLES W. HAYS, Agent, Room 7, 111 B'way, N. Y.
SHIPPING POINT—Baltimore, Md.

This coal yields 10,000 cubic feet of Gas with an illuminating power of over 16 candles. Forty bushels of very superio Coke, with little Ash and scarcely any clinker 94-1y

---

## FORT PITT GAS COAL

This Company is prepared to supply any amount of their
*Celebrated Gas Coal*
to all points reached by rail or lake throughout the West.
THE FORT PITT COAL COMPANY,
OFFICE, 337 LIBERTY STREET,
434-1y PITTSBURGH PA.

---

GAS COALS.

## THE
# PENN GAS COAL COMPANY

OFFER THEIR

**COAL, CAREFULLY SCREENED,**

AND PREPARED FOR

# GAS PURPOSES.

Their Property is located in the Youghiogheny Coal Basin, near Irwin's and Penn Station on the Pennsylvania Railroad, and on the Youghiogheny River.

OFFICES

**No. 11 Merchants Exchange, Phil'a. 90 Wall Street, New York.**

PLACES OF SHIPMENT.

**Pennsylvania Railroad, Pier No. 2 (Lower Side).**
**Greenwich Wharves, Delaware River.**
366-1y **Pier No. 1 (Lower Side), South Amboy, N. J.**

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# CANNELTON COAL COMPANY
OF WEST VIRGINIA.

Offer for sale the following Coals, from their Colliery at CANNELTON, Kanawha County West Virginia delivered at RICHMOND, Va.:

## CANNELTON CANNEL,

acknowledged to be the most valuable ENRICHER produced in this country, a gross ton yielding 10,000 cubic feet of GAS of 64·54 CANDLE POWER; COKE 32 bushels, of good quality.

## CANNELTON CAKING COAL.

*MAXIMUM YIELD*, 5.06 cubic feet of Gas per pound of Coal—A yield of 4·78 cubic feet per lb. —gave 16 14-100 Candle-Power.
**COKE**, of very fine quality—1453 pounds produced from one ton of coal.

J. TATNALL LEA, Treasurer, P. O. Box 1747 Philadelphia.
SALES AGENTS { (PERKINS & CO., 45 South Street, N. Y.; (DANIEL W. JOB & CO., 91 State Street, Boston. (H. W. BENEDICT & SON, New Haven.

---

## PARTNERSHIP NOTICE.

The partnership heretofore existing between the undersigned, under the style of *PERKINS & JOB*, is hereby discontinued by mutual consent.

Either partner is authorized to sign the name of the firm in liquidation.

NEW YORK, } Aug. 1st. 1878. JAMES D. PERKINS, }
BOSTON. } DANIEL W. JOB. }

The business of the late firm of *PERKINS & JOB*, in *NEW YORK*, will be continued by the undersigned under the style of *PERKINS & CO.*

45 South Street, }
New York, Aug. 1st., 1878. } JAMES D. PERKINS, } F. SEAVERNS, JR. }

—OO—

The business of the late firm of *PERKINS & JOB*, in *BOSTON*, will be continued by the undersigned under the style of *DANIEL W. JOB & CO.*

91 State Street, }
Boston, August 1st, 1878. } DANIEL W. JOB.

---

# CHESAPEAKE AND OHIO RAILROAD
## COAL AGENCY.

FOR THE SALE OF THE SUPERIOR

# KANAWHA GAS COALS,

ALSO,

**CANNEL,**

**SPLINT,**

**and STEAM COALS.**

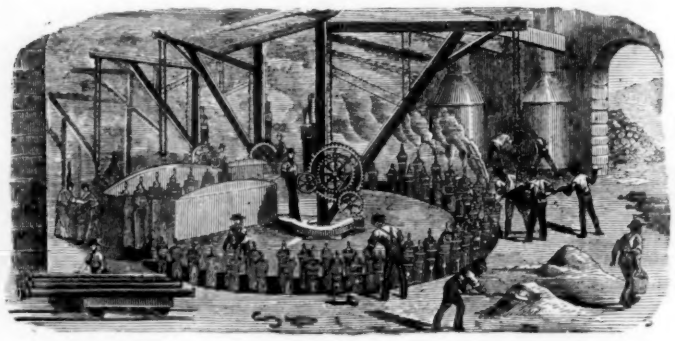
From the Kanawha and New River Regions, on the Line of the Chesapeake and Ohio Railroads.

C. B. ORCUTT, Secretary. } OFFICE No 7 WALL ST.,
J. J. GORDON, Sales Agent. } NEW YORK

# M'NEALS & ARCHER,

BURLINGTON. N. J,

Flange-Pipes



General Foundry Work.

## CAST IRON PIPES

FOR WATER AND GAS.

DAVID S. BROWN, President.
BENJAMIN CHEW, Treasurer,

JAMES P. MICHELLON, Secretary,
WILLIAM SEXTON, Superintendent.

# GLOUCESTER IRON WORKS,

GLOUCESTER CITY, N. J.

CastIron Gas & Water Pipes, Stop Valves, Fire Hydrants, Gas Holders. &c.

Office No. 6 North Seventh Street, Philadelphia.

ESTABLISHED 1856.

## WARREN FOUNDRY AND MACHINE CO.,

WORKS AT PHILLIPSBURGH, N, J.
NEW YORK OFFICE, 153 BROADWAY.

## *Cast Iron Water and Gas Pipe*

FROM TWO TO FORTY-EIGHT INCHES DIAMETER.
ALSO ALL SIZES OF

**FLANGE PIPE for Sugar House and Mine Work.**

Branches, Bends, Retorts, Etc., Etc. 436-1

## H. R. SMITH & CO.,

COLUMBUS, OHIO,

MANUFACTURERS OF

## CAST IRON GAS & WATER PIPE,

BRANCH CASTINGS, LAMP POSTS, Etc.

(Pipe from three inch and upwards cast *vertically* in 12 feet lengths.)

**HEAVY AND LIGHT CASTINGS OF ALL KINDS.**

*DAILY CAPACITY 125 TONS.*

☞ Our Works *connect direct* with *eleven railroads* centering in this city, giving us unequalled facilities for shipping to all points, at the lowest rates freight.

## NATIONAL FOUNDRY

AND PIPE WORKS.

OFFICE AND WORKS—CARROLL, PIKE, SMALLMAN AND WILKINS STREETS,

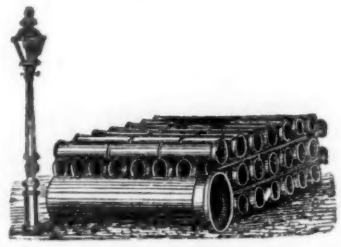
PITTSBURGH, PA

## WM. SMITH,

Manufacturer of all kinds of GAS and WATER PIPE BRANCHES, CONNECTIONS, T's, ELBOWS, and all CASTINGS USED AT GAS AND WATER WORKS,

We offer special inducements to parties wishing to purchase. My Pipe is Smooth, regular in weights, and cast vertically.

N. B.—Pipe from 3 inch and upwards, cast in 12-ft. lengths.
☞ SEND FOR CIRCULAR AND PRICE LIST.



## R. D. WOOD & CO.,

PHILADELPHIA.

MANUFACTURERS OF

## CAST IRON PIPE

FOR GAS AND WATER

Lamp Posts, Valves, Etc.

Mathew's Pat. Anti-Freezing Hydrants,

*400 Chestnut Street.*

## JAMES MARSHALL & CO.

**Franklin Foundry and Pipe Works,**

MANUFACTURERS OF

**GAS, WATER, AND OIL PIPES**

Works, 18th, 19th, 20th and Railroad Street.
Office, No. 23 Nineteenth Street.

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N.B.—Pipes from 3-inch and upwards cast in 12 ft. lengths.
☞ Send for Circular and Price List.

## BERGEN IRON WORKS.

ROBT. CAMPBELL & CO.

MANUFACTURERS OF

## CAST IRON PIPES,

FOR WATER AND GAS,

Valves, Fire and Dock Hydrants,
Lamp-Posts and Flange Work,
Bench Castings for Gas Works, &c.

Office 112 Leonard Street, N. Y.

## B. S, BENSON.

MANUFACTURER OF

Cast Iron Pipes and Fittings

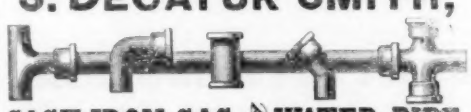
AND

**Gas and Water Mains.**

All sizes from 3 to 30 inch cast vertically in 12½ feet lengths

Office & Factory 52 East Monument St.,
BALTIMORE, MD.

## S. DECATUR SMITH,



## CAST IRON GAS & WATER PIPE,

Foundry, Cor. of York and Moyer Streets,

PHILADELPHIA.

Several Thousand 2, 3, 4, 6 and 8 Inch Cast Iron *Gas and Water Pipes* on hand, for immediate delivery.

FITTINGS FOR GAS WATER MAINS.

A

MURRAY & BAKER,

**Practical Builders,**

**And Contractors for the Erection of Gas Works,**

MANUFACTURERS OF ALL THE LATEST AND MOST IMPROVED APPARATUS AND TOOLS FOR THE MANUFACTURE & DISTRIBUTION OF COAL GAS.

☞ WORKS AT THE RAILWAY DEPOTS,

**FORT WAYNE, INDIANA.**

We manufacture Bench Castings, Washers, "The Immersed Multitubular," and Atmospheric Condensers, Wet and Dry-Lime Purifiers, Dry Center Seals, Telescopic and Single Gas Holders, Wrought Iron Trussed Roof for Iron or Slate, Wood and Iron Trays for Purifiers, Coke and Coal Carts, Wrought Iron Screening Shovels and Castings, and Wrought Work of every description for Gas-Works.

As Mr. Murray is a Practical Draughtsman, we will furnish plans and specifications to parties or associations, or will wait personally upon parties contemplating the construction of new works, or the alteration or extension of old ones

The most satisfactory references can be given, if required of the experience and commercial fairness which characterizes our dealings.

We would respectfully invite Western men to call and see our patterns and works here. MURRAY & BAKER,
Fort Wayne, Indiana

GEO. STACEY. HENRY BANSHAW WM. STACEY

**GEO. STACEY & CO.**

MANUFACTURERS OF SINGLE AND TELESCOPIC

**GAS-HOLDERS,**

AND ALL KINDS OF

**Cast and Wrought Iron Work**

Used in the Erection of Gas and Coal Oil Works.

Foundry on MILL STREET; Nos. 33, 35, 37 and 39.
Office and Wrought Iron Works on RAMSAY STREET Cincinnati, Ohio.

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| Cincinnati Gas-Light Co. | Baton Rouge, La., Gas Co. |
| Indianapolis Gas Co. | Saginaw, Mich., Gas Co. |
| Dayton, O., Gaslight Co. | Oshkosh, Wis., Gas Co. |
| Covington, Ky., Gas Co. | Peoria, Ill., Gas Co. |
| Springfield, O., Gas Co. | Quincy, Ill., Gas Co. |
| Terre Haute, Ind., Gas Co. | Champaign, Ills., Gas Co. |
| Madison, Ind., Gas Co. | Carlinville, Ill., Gas Co. |
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**BROWN & OWEN,**

MANUFACTURERS OF

EVERY DESCRIPTION OF

**Gas and Water Works Supplies.**

Particular attention given to the alterations of old works
Estimates and Drawings furnished.
Address all communications to

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420-1y **PHILADELPHIA.**

HERRING & FLOYD,

**Oregon Iron Foundry**

738, 740, 742 and 744 Greenwich St,, N. Y

MANUFACTURERS OF

ALL KINDS OF CASTINGS
AND
APPARATUS FOR GAS-WORKS.

BENCH CASTINGS
from benches of one to six Retorts each.
WASHERS: MULTITUBLAR AND AIR CONDENSERS: CONDENSERS; SCRUBBERS,
wet and dry), and
EXHAUSTERS
for relieving Retorts from pressure.
BENDS and BRANCHES
of all sizes and description.

FLOYD'S PATENT
MALLEABLE RETORT LID.

SABBATON'S PATENT
FURNACE DOOR AND FRAME.

SELLER'S CEMENT
for stooping leaks in Retorts.

GAS GOVERNORS,

and everything connected with well regulated Gas Works, at low price, and in complete order.
N. B.—**STOP VALVES** from three to thirty inches—very low prices.

SILAS C. HERRING JAMES R. FLOYD

1842. DEILY & FOWLER 1878.

*LAUREL IRON WORKS.*

ADDRESS, 39 LAUREL STREET,

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MANUFACTURERS OF

**GAS HOLDERS,**

*SINGLE AND TELESCOPIC—WITH CAST OR WROUGHT IRON GUIDE FRAMES.*

We are prepared to furnish Holders, Wrought Iron Roof Frames, Bench Castings, Condensers, Scrubbers. Purifiers, Drips, Bends, Tees, and all other Iron Work connected with Gas Works. Previous to 1868 our Mr. D. built *nine Gas Works* and *fifty-four Holders*. Since that date we have built *three Gas Works* and *forty-six Holders*. We *superintend in person* the erection of all our work, and would refer to the Gas Companies at the following places, where we have built Holders since 1868:

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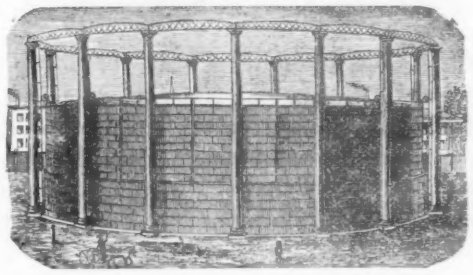
|---|---|
| Lancaster, Pa. | Barnesville, O. |
| Williamsport, Pa. | Franklin, Ind |
| Bristol, Pa. | Jacksonville, Ill. (2) |
| Catasaqua, Pa. | Joliet, Ill. |
| Kittanning, Pa. | Lawrence, Kansas. |
| Hazelton, Pa.) | Jefferson City, N. O. La |
| Freeport. Pa. | Algiers, N. O., La. |
| Huntingdon, Pa. | Kalamazoo, Mich |
| Pittston, Pa. | Buffalo, N. Y. |
| Bethlehem S). Pa. | Ogdensburg, N. Y. |
| Sharon, Pa. | Waverly, N. Y. |
| Canton, Pa. | Little Falls, N. Y. |
| Annapolis, Mo. | Penn Yann, N. Y |
| Parkersburg, Wes, | Watkins, N. Y. |
| Lynchburg, Va. | Gloucester, N. J. |
| Youngstown, O | Salem, N. J. |
| Steubenville, O. | Mount Holly, N. J. |
| Zanesville, O. | Plainfield, N. J. |
| Mansfield, O. | Englewood, N. J.; |
| Marion, O. | Dover, Del. |
| Bellaire, O. | Pittsfield, Mass. |
| Athens, O. | Meriden Conn- |

**CONTINENTAL WORKS.**



GASHOLDERS OF ANY MAGNITUDE.

T. F. ROWLAND, Proprietor.

GREENPOINT, BROOKLYN, N. Y.

ENGINEER AND MANUFACTURER OF

**GAS-HOLDERS.**

CONDENSERS, SCRUBBERS, VALVES, PURIFIERS, RETORTS, and HYDRAULIC MAINS,

and all other articles connected with the Manufacture and Distribution of Gas. Plans and Specifications prepared, and Proposals given for the necessary Plans for Lighting Cities Towns, Mansions, and Manufactories.

**NATIONAL COAL GAS COMPANY.**

320 Broadway, N. Y., Rooms 50, 51 & 52.

Elevator on Pearl Street.

**H. P. ALLEN, President.**

The process known as GWYNNE-HARRIS but from later most essential improvements more appropriately called the ALLEN-HARRIS, or AMERICAN HYDROCARBON process for making "Water Gas," by the decomposition of superheated steam, in fire-clay retorts, set similarly to those in Coal Gas Works, is an established success. More than One Hundred Million cubic feet of gas have been made under this process, and for *permanency* and *brilliancy*, as well as economy both to the manufacturer and consumer, it is superior to any gas made by the old, or any other method.

Our process is *not intermittent* but continuous. The steam and the oil are admitted into the retorts by gauge cocks, and run for days without change. All the materials required, besides the steam, are 17 lbs. of Anthracite coal and about 3½ gallons of Petroleum or Naphtha, per 1000 feet of brilliant gas.

Rights for sale. Inquire of the President.

JESSE W STARR & SON,

**Camden Iron Works**

**Camden, New Jersey,**

**Office in Philadelphia No. 435 Chestnut St., where a member of the Firm can be seen between 12 m. and 2 p. m. daily.**

MANUFACTURERS OF

ALL KINDS OF CASTINGS AND APPARATUS FOR GAS WORKS,

**Wrought Iron Roof Frames,**

For Retort and other houses. Retorts and all castings required for setting them in the latest and most improved model. WASHERS, CONDENSERS, SCRUBBERS and EXHAUSTERS for relieving the Retorts from pressure. PURIFIERS, varying from 2,000 to 2,000,000 cubic feet daily purifying capacity.

**Wrought Iron Lime Sieves**

for Purifiers. Station Meters of all sizes.

**GAS HOLDERS.**

TELESCOPIC AND SINGLE

With cast iron guide and suspension frame GAS GOVERNORS or REGULATORS, STREET MAINS, from 1½ 48 INCHES DIAMETER, for WATER or GAS. Street Main connections, such as BRANCHES, BENDS, DRIPS, SLEEVES, etc.

STOP VALVES, from 3 to 30 inches, for both Water and Gas.

**Wrought Iron Work.**

All the Smith and Sheet Iron work required in and about Gas Works. 226-tf

JESSE W. STARR. JESSE W STARR, Jr.

**MACKENZIE & SAYRE MAN'F'G CO.,**

**141 BROADWAY, NEW YORK.**

**Gas Works, Smelting Works & Machinery.**

Proprietors of P. W. MACKENZIES PROCESS AND APPARATUS for making Illuminating Gas from Ordinary Gas Coals, enriched with Cannel or Oil. Also, Mackenzies Process for Making Heating Gas for Smelting, Melting, Puddling, Forges, Boilers, Etc. Also,

**P. W. Mackenzie's New Engine and Boiler.**

434—1y

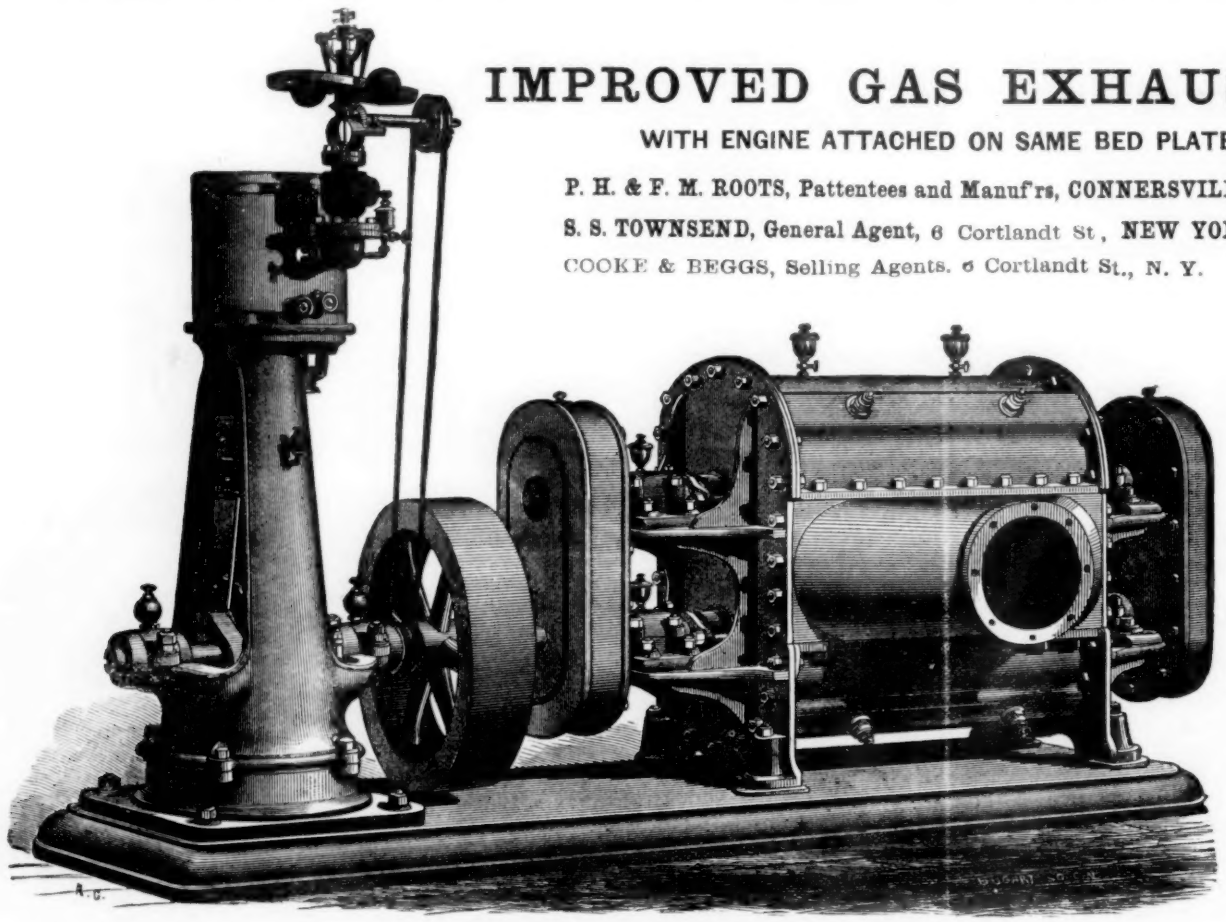
# IMPROVED GAS EXHAUSTER,

WITH ENGINE ATTACHED ON SAME BED PLATE.

P. H. & F. M. ROOTS, Pattentees and Manuf'rs, CONNERSVILLE, IND.

S. S. TOWNSEND, General Agent, 6 Cortlandt St, NEW YORK

COOKE & BEGGS, Selling Agents. 6 Cortlandt St., N. Y.



ADVANTAGES CLAIMED FOR THIS EXHAUSTER.

1. It is simpler than any other Exhauster. The internal operating parts consist of only two pieces, cast entire, and can not get out of order.
2. Every part requiring care or attention, is external and easily accessible. All changes, adjustments, and repairs are made from the outside.
3. The revolvers, though practically gas-tight, do not run in actual contact, hence there is no friction, and a great saving of power effected.
4. They are built in the most complete and substantial manner, and of any required size, with steel shafts and improved journal bearings.
5. We furnish Exhausters and Engines combined on same Bed Plate, as shown above, or the Exhauster only, as may be required.
6. We also furnish Bye Passes and Gas Valves on improved plans, also Exhauster Governors and Elbows, Pipes, Drawings, etc.

Send for Illustrated Catalogue, giving details of capacity. speed, power required, price, and references to parties using them.

P. H. & F. M. ROOTS.

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**J. H. GAUTIER & CO.,**

CORNER OF

GREENE AND ESSEX STREETS,

*JERSEY CITY, N. J.*

MANUFACTURERS OF

**Clay Gas Retorts,**

**Gas House Tiles,**

**Fire Bricks, Etc. Etc.**

**Ground Clay, Fire Brick and Fire Sand in Barrels,**

*ALWAYS ON HAND.*

J. H. GAUTIER.
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**Brooklyn Clay Retort**

AND

**FIRE-BRICK WORKS.**

Manufacturers of Clay Retorts, Fire Bricks, Gas House and other Tile, Cupola Brick, etc. Dealers in and Miners of Fire Clay and Fire Sand. Clay bank at Burt's Creek, New Jersey. Manufactory: Van Dyke, Elizabeth, Richards and Partition Streets, Brooklyn, N. Y. Office, No. 88 Van Dyke Street.

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FIRE BRICKS AND

**GAS RETORT WORKS**

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Hand and Machine made Retorts and Settings, Superior Fire Bricks for Siemans Gas and Glass Furnace. Bricks and Tiles for Whitwell's Hot Blast Ovens, Blast Furnace and Cupola Tiles, Etc.

*Fire Bricks and Tiles*

of all shapes and sizes.

Glass Pot Clay. Fine Ground Clay and Fire Bricks. Sewer Pipe, Etc.

**901 Pine Street, St. Louis, Mo.**

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**MANHATTAN**

FIRE BRICK & ENAMELLED CLAY

**RETORT WORKS.**

ADAM WEBER,

(Successor to MAURER & WEBER.)

PROPRIETOR.

**Office and Works, 15th Street, Avenue C.**

Manufactures of

**FIRE BRICK AND TILES,**

Of all shapes and sizes.

FIRE MORTAR, CLAY AND SAND.

☞ Articles of every description made to order at short notice. 1y5t.

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Works:
LOCKPORT, PA.

*Established 1864.*

Works:
MT. SAVAGE JUNCTION, MD.

**GARDNER BROTHERS,**

**Manufacturers of Clay Gas Retorts and Retort Settings,**

"STANDARD SAVAGE"

**Fire Brick, Tile and Furnace Blocks,**

AND

Sole Agent for New England,
C. H. SPRAGUE,
86 State Street, Boston.

**MINERS AND SHIPPERS OF FIRE CLAY.**

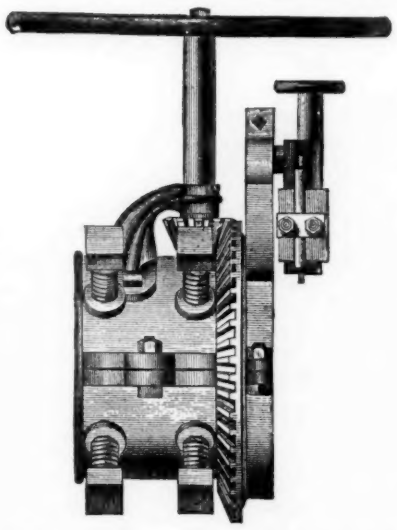
OFFICE No. 376 PENN AV'E., PITTSBURGH, PA.

# A. C. WOOD'S
# CAST IRON PIPE CUTTER

PATENTED MAY 23rd, 1876.

*PRICES REDUCED TO MEET THE TIMES.*

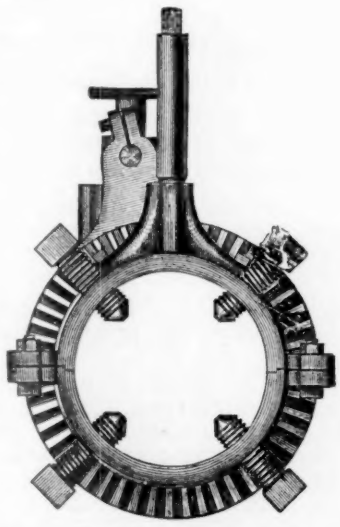
We have been able to reduce the cost of Manufacturing, and desire to give our Customers the benefit at the following



**REDUCED RATES:**

*No. 1 cuts 3, 4 and 6 inch Pipe* $75
*No. 1 1-2 cuts 4, 6 and 8 in. Pipe,* $85
*No. 2 cuts 8, 10 and 12 in. Pipe,* $100
*No. 3 cuts 16, 18 and 20 in. Pipe,* $225
*NO. 4 cuts 24 and 30 inch Pipe,* $275
*No. 5 cuts 36 inch Pipe,* $350

*For larger sizes Special Contracts will be made.*



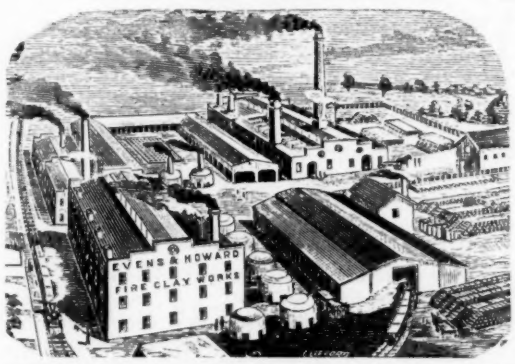
**It will cut a Continuous Line of Pipe in a Trench or Building**

As well as loose Cast or Wrought Iron Pipe, Shafts or Columns of any size, leaving the ends clean, smooth, and square.

Our Machines for cutting 20 and 30-INCH PIPE have been furnished the Manhattan and New York Gas Light Companies; also for cutting 12, 20, and 30 inch Pipe to the Boston Gas-Light Company. The smaller sized Machines have been in practical use in various parts of the country by Water and Gas Companies, for over two years, and all with the most satisfactory results. Address

A. C. WOOD, Syracuse, New York.
HERRING & FLOYD, No. 744 Greenwich street, N. Y.
BROWN & OWEN, 20th and Filbert Sts., Philadelphia.
MORRIS, TASKER & CO., 36 Oliver Street, Boston, Mass.

## EVENS & HOWARD.




**GAS RETORTS,**
**FIRE BRICK,**
*Retort Fittings,*
**FURNACE & CUPOLA LININGS**
OF EVERY DESCRIPTION.
Sewer Pipe and Drain Tile.
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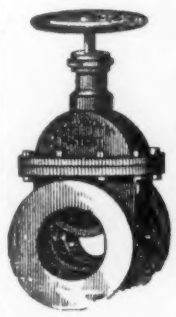

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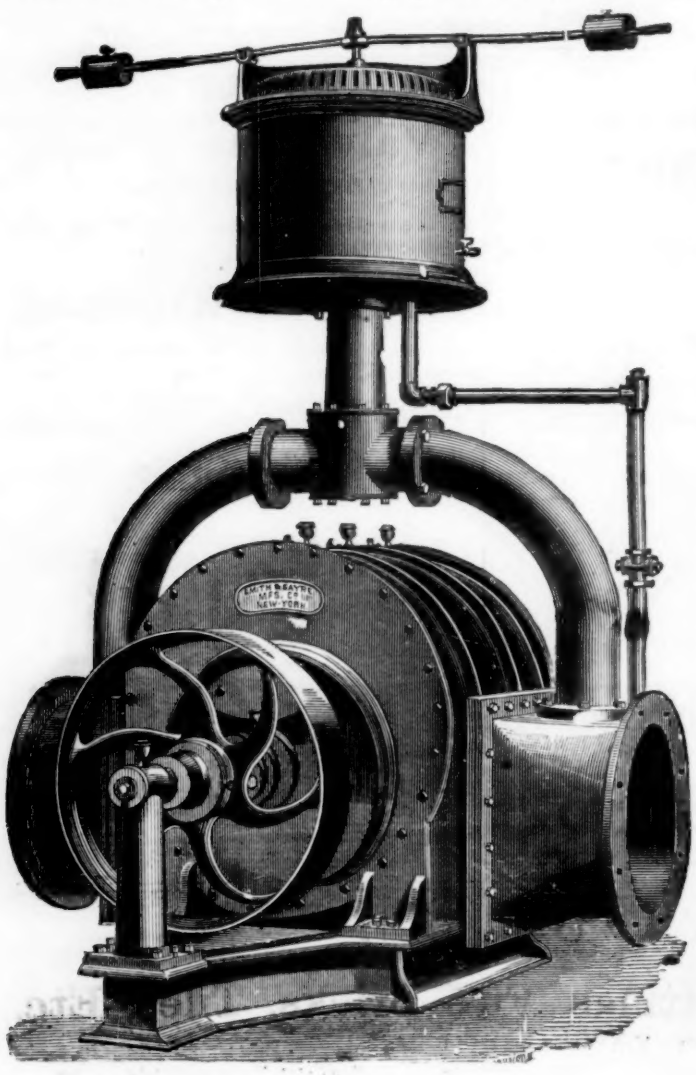


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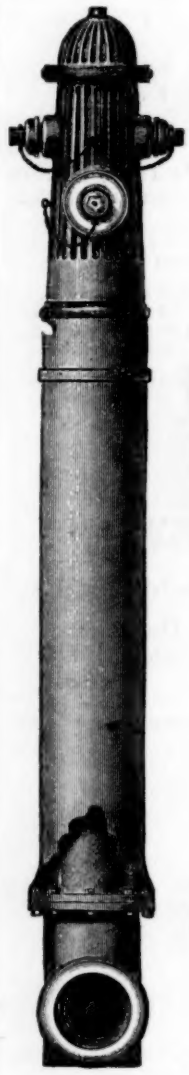

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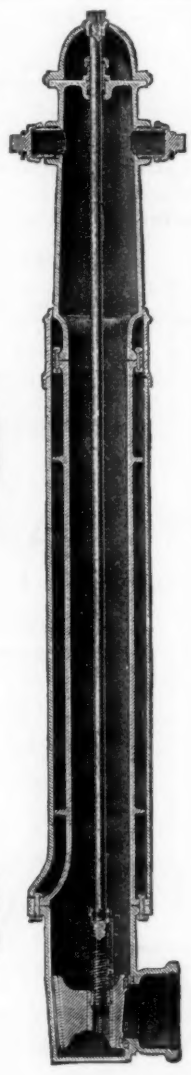

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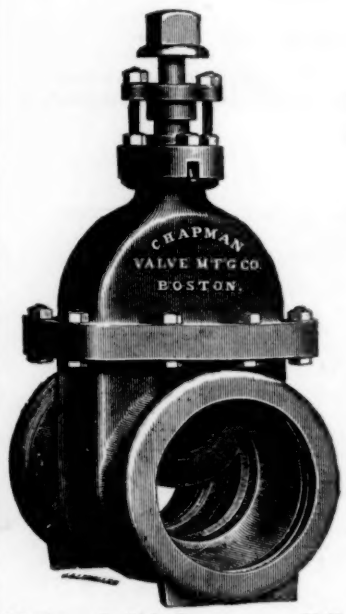


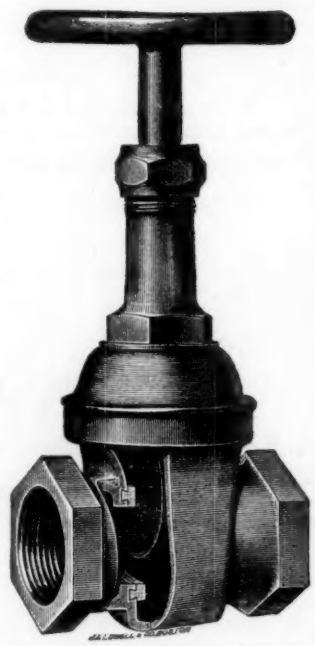

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